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What an efficient standardization committee can accomplish in the car department of a large railroad system is well shown by the work of such a committee on the Rock Island and Frisco systems in designing a standard 40-ton box car, illustrated on another page in this issue. It is difficult to find a weak spot in the fundamental reasons underlying the general features of the design, or in the details as they have been worked out in the complete car. The value of team-work is apparent. Strength has not been sacrificed for low tare weight, due attention has been given to ease of repairs at isolated points where special material is not available and special tools are not at hand, and the needs of the traffic which will be handled by such cars have been met. We understand that the committee is at work on other standard designs of freight equipment along much the same lines.

One feature of the Rock Island-Frisco car is the use of steel members in the body framing. Aside from the draft attachments, the weakest points of a box car are the roof and the ends. With the ordinary wood framing it is almost impossible to keep all the members of the side truss rigidly in place and prevent twisting and distortion of the whole body. It is this twisting and swaying that destroys the effectiveness of car roofs much quicker than exposure, walking on them, or damage from other causes. The green wood put in cars warps and shrinks in seasoning and tightening the brace rods or plate rods has little effect. With a fairly strong and rigid steel side and end frame the body is made an integral part of the underframe. The value of the side trussing in carrying part of the load is almost negligible with wooden construction, except under excessive deflections of the sills. By the introduction of deep cross-bearers under each door post in this car, however, the steel side frame serves a useful purpose in carrying part of the load between the bolsters and the blank door panel. The end framing is substantial enough to withstand any ordinary shifting of the load without breaking or bulging.

When a railroad wreck occurs as a result of a broken or defective wheel, who is responsible for the loss of life and property? Is it the purchasing agent who bargains like a Shylock for the cheapest wheels he can get, regardless of their quality and ability to stand the strains to which they are subjected in service? Is it the mechanical officer who knows, or at least should know, good wheels from bad wheels, and who still allows cheap and inferior wheels, utterly unfit for the service they are to perform, to be put under the cars in his charge? Is it the wheelmaker who makes bad wheels that will stand acceptance tests but that he knows will not stand service strains, justifying himself on the theory that he has given the railroads all the quality he has been paid for? This is the real cast-iron wheel question, stripped bare of all side issues and looked squarely in the face. Wheel failures under high capacity cars are becoming more and more frequent, and, with increasing density of traffic, more dangerous. If cast-iron wheels of the best quality are not safe to run under high capacity cars, it is little less than criminal to go on putting them under such cars. If defective and inferior wheels are bought because they are cheap, it is more than criminal on the part of the man who makes such wheels and the man who knowingly buys them. Discussions over specifications and tests and guarantees only serve to divert attention from the real trouble, which is trying to make wheels for less than the cost of raw material. It would be a great good if more effort was made by all concerned to see how good a wheel can be made in cast iron instead of how good a wheel can be made for $6.89.

RAILROAD OFFICERS' INVESTMENTS.

"Have you a ruffian that will . . . commit
The oldest sins the newest kind of ways?"
—*Shakespeare, King Henry IV.*

Forty years ago, soon after Dr. E. H. Williams became general superintendent of the road then generally known as the "Pennsylvania Central," the good doctor made to a friend a statement in substance as follows: "These people are going to make me rich. Before I fairly got settled in my new office a certificate for shares of express company stock, made out in my name, came to me, but I sent it back, explaining that I could not afford to pay for it. Then a fast freight line certificate came, and I treated the matter in the same way. Then others came and I concluded to report the whole matter to the President, J. Edgar Thomson. He told me that it was the policy of the company to have its responsible officers relieved of private cares and anxiety. They should have a competence and be in a position to give their best energies to the company's service.

He further said that it was good policy for the general officers to be interested in the great industries which made business for the road. I was advised to accept the certificates which I had refused, but in all cases in future to report to him whatever ownerships I might acquire in companies doing business with the Pennsylvania."

This is recalled, not for the purpose of preaching, which does no good, or for "searching out the hearts of men before the judgment seat," where we have no jurisdiction. It is, rather, to show that to observers of the methods of individuals and corporations controlling large undertakings nothing new has been developed by the testimony to the Interstate Commerce Commission of the relations between the Pennsylvania officers and the coal companies, except that some coal companies have bribed employees, and that one of them has paid cash to a high officer. This vulgar incident has the slight merit of making vice unattractive.

Mr. Thomson's policy was sound, not only in relieving his officers from private cares and getting for the company all the initiative and power of minds unharrassed, but also in making incentive for able men. The result is fine—a staff of educated, able, honorable men, unsurpassed perhaps in these respects by that of any large corporation or club or church; for the coefficient of human error is large and variable, and sinning is as old as Adam. But while this policy aided probably in producing this result during the earlier period when car shortages were little known, and when there was no concealment by the railroad officer of his money interest in corporations which were customers of the road, nevertheless it is a dangerous policy. There is another obvious criticism: If it is desirable for the railroad service to have the general officers well-to-do the money should come from the company's treasury, and not be taken as tribute from the customers. It is not a sufficient answer to this to say that public sentiment compels the railroads to contribute to the spread of the Gospel by giving half fare to preachers, or that state governments compel railroads to pay the salaries of railroad commissions, or that the price of decent treatment by public officers and newspapers has been free transportation.

Opportunities to make money come to men who have power. It is not necessarily wrong to sell influence, to receive free stock for help or for the use of a name, but it is dangerous. Most good things are dangerous. Not long ago an important railroad officer became convinced by his own investigations that an extension of his company's line would make possible a great industry whose business would be highly profitable to his road. He advocated and secured the building of the extension. It was immediately profitable, and the industrial undertaking was profitable, and he was offered a substantial amount of its stock. But his president, whom he consulted, advised him to refuse it. Upon this statement of facts some persons will judge this president harshly and regret his subordinate's earned and lost opportunity. Others will believe that the president properly stopped the transaction, not because it was wrong or harmful, but for fear of a precedent for less justifiable or more dangerous ones.

It is the rule, not the exception, that railroad officers are imbued with a high sense of duty and a readiness for self-sacrifice far beyond that which prevails in other commercial undertakings. This is a condition naturally and necessarily developed in a service where carelessness or any slight relaxation of attention to duty may make a loss of life and property. The responsibility is such that hours of work or intensity of work are limited only by physical possibilities. Successful administration is that which keeps the company out of trouble and somewhat diminishes public complaint. Those who fail in ceaseless vigilance drop by the wayside, but beyond this negative result there is the hope for promotion to a position of power. And here there are not only legitimate chances, but also insidious temptations which test not only the man's basic principles of morality but also his judgment on questions new to him—like those which Dr. Williams described to his friend.

It is not difficult to see that there is a primary wrongdoing in the organization of industrial and other companies in such a way that "full paid" shares are in the treasury, ready to be given away without recording in the books of the company the money or other value received for them. The common way of doing this is to record the purchase of patents or good will or property at a price which will equal all, or nearly all, the capital stock to be issued. The seller then returns to the company such an amount of stock as represents the over valuation of what he has sold. Over valuation is wrong, and the full paid stock in the treasury is the result of it. Perhaps, therefore, this stock is "tainted," and one should neither buy it nor receive it. Honest folks differ in opinion of the use of tainted money as well as tainted stock.

It is a time for corporate house cleaning, and it is to be hoped that it may be thorough. That the clamor for it is insensate makes no difference. It should be done, although the demand for purity is too apt to be a passing fever of that great body of people with fragmentary morals picked up casually and adapted to criticism of incidents made public day by day; glib folks with capacity to "form and express a great variety of opinions on a great variety of subjects."

THE BURLINGTON ASSOCIATION OF OPERATING OFFICERS.

The Burlington Association of Operating Officers, organized for the purpose of promoting co-operation between these officers and of advancing the standards of practice of the road, which originated in a very modest way a good many years ago, has been in existence in its present form for a little more than three years. The good results which may be attributed directly to the existence of this association make an account of its organization, history, method of operation and something of what it has accomplished of very great interest. For the information contained in the following we are indebted to Mr. S. D. Brown, Secretary of the association.

The Burlington Association of Operating Officers as at present organized on the Chicago, Burlington & Quincy Railway is the outgrowth of a very small beginning. On March 10, 1886, in response to a call previously sent out, the master mechanics of the Chicago, Burlington & Quincy and system lines, met at Aurora, Ill., and organized a Master Mechanics' Association with a membership of 15 or 20 officers representing the mechanical department. Mr. G. W. Rhodes, then Superintendent of Motive Power, was elected Chairman and served in that capacity until 1903. Meetings were held semi-annually until 1898; since then sessions have convened annually. One of the objects in forming this organization was the discussion of questions of mechanical details, and the establishing of standards and practices in the motive power department for the government of all concerned. Interest in the meetings was manifested from the very first, not only by the members themselves, but by other officers of the road. In November, 1896, the superintendents first met in joint session with the master mechanics and also organized a Superintendents' Association. From that time until 1902 meetings were held both jointly and separately by these associations. In March, 1903, these meetings were consolidated and the Burlington Association of Operating Officers organized with a constitution and by-laws.

The officers of the association consist of a chairman, a first and second vice-chairman, and a secretary, who perform the duties usually devolving upon such officials. The executive committee is composed of the chairman and vice-chairman of the association, together with the general managers of the Lines West and East of the Missouri River, or a representative appointed annually by them. This committee selects from among the subjects which the members have been invited to hand in, those which appear to be of general interest, and the members are notified through printed programmes of all new subjects introduced for discussion at least three weeks prior to the meeting at which such subjects are presented. They decide on the time and place of all meetings of the association and in other ways have general charge of its affairs. Altogether 38 meetings have been held and 16 different points on the line have been visited. These latter included Chicago, Aurora, Omaha, Kansas City, St. Louis, Denver and St. Paul. A regular order of business is followed, and the meetings are conducted somewhat in the same way as those of the Master Car Builders' and American Railway Master Mechanics' associations. Fifteen members, including the chairman, constitute a quorum for the transaction of business. The membership of the association consists of the general officers of the system and the following representatives from the Lines East and Lines West: General managers, general superintendents, assistant general superintendents, superintendents of divisions and terminals, assistant superintendents of divisions and terminals, chief engineers, engineers of Lines East and of Lines West, engineers of maintenance of way, superintendents of motive power, mechanical engineers, engineers of tests, superintendents of shops, master mechanics of divisions and terminals, assistant master mechanics of divisions and terminals, general piecework inspectors, mechanical inspectors, inspectors of transportation, supply agents, and auditors. Officers of the various departments not eligible for membership may be present at any meeting of the association upon invitation of the heads of their respective departments of the executive committee, but do not take part in the proceedings unless invited by the chairman. The present active membership of the association is about 90.

Committees for the investigation of special subjects ordered by

the meetings are appointed by the chairman and serve until discharged by action of the meeting. There are also several standing committees, such as Motive Power Statistics, Motive Power Standards, Train Rules, Permanent Way, Blanks, etc. Since the organization of the association in 1886 something over 1,000 subjects have been considered. Nearly 60 per cent. of these have been submitted to the management, approved and made the standard practice of the road.

From a mechanical department standpoint the association has been instrumental in bringing about a great many standards relating to rolling stock and other equipment of the road. It has tended to diffuse much information concerning new practices and ways of doing work between the different shops which otherwise would have remained as purely local matters, thereby reducing the cost. It has created a lively interest and rivalry between different divisions in the matter of economy and workmanship. One of the particular aims of the association has been the co-operation of the different departments, the bringing together of superintendents, master mechanics and others, and interesting them in each others' work through the discussion of subjects of mutual interest, such as maintenance of permanent way, structures of all kinds, operation of trains, handling of freight, etc., which are of interest to master mechanics and superintendents alike.

A concluding thought may well be expressed in the words of a former member, who said, "I have very great faith in the efficiency of the workings of this joint association. I believe that in years to come the progress of the Burlington road will be written in the minutes of this association; the progress in economies, progress in improved methods, progress in all material things will be written in the minutes of these meetings."

THE PASSING (?) OF THE STEAM LOCOMOTIVE.

Not many months ago it was stated in Congress (jocularly, let us hope) that in 10 years the steam locomotive would exist only in museums, as a relic of bygone methods of transportation, but there is certainly no evidence to warrant such an assertion. In some particular localities, the electric locomotive will soon displace those operated by steam, the transposition being made on an elaborate scale, but it must not be argued from this that any such movement will become universal. Very good reasons exist in these special cases for the change to electric power, and in each case an extremely great density of traffic obtains in the territory undergoing the transposition.

Motor cars are also making their appearance in limited numbers where certain exigencies in the traffic create a seeming demand for this type of vehicle. Some economy of operation is claimed for the motor car, but where the electric locomotives are being installed, the question is one of greater importance than bare economy—enlargement of the traffic and the proper facilities for handling the same. A year ago, Mr. Wilgus, vice-president of the New York Central, made this very clear by some pertinent remarks in discussing a paper presented by Mr. W. B. Potter, before the New York Railroad Club, and we do not know that his statements have since been controverted. He demonstrated that the contingent expenses were enormous (in the New York Central's scheme at least), and that the actual expense of electrifying suburban service would be only about 25 per cent. of the amount spent to secure the full value and benefits of such electrification. He further stated that the question had not been looked upon as decreasing the cost of operation, but rather from the standpoint of being able to build up an increase of business, not only from the more attractive and smokeless locomotives for the Park avenue tunnel, but also by the increase in capacity of terminal facilities which electric traction offered.

The locomotive tests of the Louisiana Purchase Exposition demonstrated the economical efficiency of the ordinary steam locomotive in a way that admits of no dispute, the committee which conducted the experiments testifying that "it is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse-power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant." Modern gas engines and producers will do little better than a horse-power hour per pound of coal, and with 30 per cent. loss in generation, transmission and conversion, we have a fuel consumption at the electric locomotive of 1.4 lbs. of coal per horse-power hour as compared with 2 lbs. for the steam locomotive. There will likely be reductions in the cost of repairs, as there will be no boilers to maintain (except at the power stations), but of course, the maintenance of the electrical apparatus is in some respects an unknown factor.

The capital expenditure necessary to perform the same work is very much greater with electric traction: a modern steam locomotive, capable of exerting 15,000 h.p., can be purchased or built for about $15,000, or approximately $10 per horse-power. The investment for a horse-power in electrical equipment will be something as follows:

Gas producers	$20.00
Gas engines	45.00
Housing	10.00
Generators and switchboard	15.00
Electric locomotives	15.00
Total	$105.00

By the time our transmission lines were in we should probably have a first cost not far from $120 per horse-power developed on the rails, although the distance of transmission and the density of traffic would affect very greatly the cost of distribution.

A locomotive exerts its full power but for a small fraction of the time that it is running, and it often runs much less than one-half of the time, due to road and terminal delays. Three thousand miles a month is a fair average for freight locomotives, which means 100 miles per day. At 10 miles an hour average speed, less than half of the time would be spent in performing useful work. This is not all due to terminal delays, as the lay-overs, while on the road, are likely to be as great as those at division points. If we consider that it exerts its full power for one-half of the time that it is running, we will not be understating the "work performed." The balance of the time, perhaps half of its maximum power is developed, which would give us an average of three-eighths of the full capacity of the engine, but one-third would no doubt be closer to actual conditions as they exist on railroads in this country. We can check this roughly by remembering that while 200 lbs. of coal *can* be burned per square foot of grate surface per hour, less than 100 lbs. will be the average consumption for a trip. The fuel saving (as demonstrated above) may be $2 - \frac{1}{4} = .6$ pound per horse-power hour, and at one-third of the time for full capacity, we should have an actual saving of $.6 \div 3 = .2$, or one-fifth pound of coal per hour. These figures are, of course, only roughly approximate, and would vary greatly with individual cases, but we believe that they do not err sensibly on the side of the steam locomotive. As there are 8,760 hours in a year, we should save (on the above basis) 1,752 lbs. of coal, or say, 1 ton in round numbers for each horse-power of locomotive in service, figuring the horse-power by the size of the boiler and cylinders. With coal at $1.50 per ton, we should save in fuel about ½ per cent. on the extra capital investment.

Steam locomotives lose much time in the round house on account of frequent boiler washings and repairs, and these necessitate cooling the boiler and firing it up again. Including the work, this may require from 5 to 8 hours, depending upon the kind of fuel used and the facilities at the point where the work is done. If we concede that the electric locomotive can make double the mileage, we might double this saving, but still not have an attractive financial proposition. As stated previously, there will no doubt be reduction in the cost of repairs to the locomotives, and if we assume that it will be cut in half per horse-power, the figures will appear somewhat as follows:

Value of locomotive	$15,000
Cost of repairs, per year	3,000
Reduction of one-half	1,500
Horsepower of locomotive	1,500
Repairs per year per horse-power	1

This added to double the fuel saving estimated above makes a total of $4.00 per year on an extra investment of at least $100. There are other expenses which might be reduced, but on the other hand, there are power house maintenance and repairs, and as a general proposition, it is evident that the electric locomotive will not be universally adopted on the basis of economy, unless in some particular localities, where coal is dear and water power abundant; where the density of traffic is great and the facilities for rapid train movement may demonstrate a paying investment; or where there are tunnels that cause difficulty in ventilation, or particular grades that could be more efficiently handled by electric than by steam locomotives.

If electric power is advocated for density of traffic, motor cars are introduced where the converse is true; where traffic is light and not thought sufficient to pay for ordinary train expenses. Here the principal saving is in train crew wages. We have seen that the gas engine costs two or three times as much as a locomotive of equal power, and gasolene at 10 cents a gallon is three times as

expensive as coal at $1.50 per ton. The clutches for speed variation are not very desirable attachments to rolling stock, as is evident by gasolene-electric combinations, which double the first cost and increase operating charges at least 25 per cent.

It is true that we can use steam engines and boilers, but the washouts and other performances to which steam boilers are periodically subject, are not conducive to the satisfactory maintenance of the passenger end of the vehicle. While the "repair track" is certainly not the place to make repairs to machinery and boilers, neither is the round house the proper locality to protect a car. If repairs are needed to one or the other, it practically ties up a train, and the difficulty of turning at the ends of short branch runs may be quite a serious consideration, where a light locomotive can simply uncouple and pass around a siding. If the particular service requiring motor cars should diminish, either periodically or permanently, little use would be found for such equipment, where a separate locomotive and car could readily be used to advantage.

The wages of the train crew are the principal items of saving expected, but it is uncertain how long such economies may be enjoyed, in the light of recent legislation and the efforts of labor organizations.

The general availability of railroad equipment for various uses is an important consideration in purchasing cars and locomotives and the motor car is not likely to share in these advantages with a light locomotive or are discarded from main line usage (of which most roads have more than they know what to do with) and a combination car. The difficulty of maintaining special equipment at out-of-the-way points is another thing to be considered. There is little data on the cost of construction and operation of these combination types, but it is extremely doubtful if they will ever be used in large numbers or in fact as generally as enthusiasts now claim to foresee.

Upon considering the above facts, it appears that there is no reason why the improvement and perfecting of the steam locomotive should not be pushed with vigor. There is much room for improvement, and the Pennsylvania Railroad tests will throw light upon the direction to turn for promising results. Superheating is in its infancy in this country and promises to do much in saving fuel and reducing boiler repairs. The recent interest in treating water, and the improvements (sadly needed) in terminal facilities will materially benefit the service performed by the steam locomotive, and much real progress is looked for in these directions.

We do not by any means wish to impede the introduction of electric traction; on the contrary, we believe that too much attention and thought cannot be given to it, but the proper limitations must be studied and observed. The New York Central terminal and the Atlantic City line are admirably adopted to the substitution of electric power for steam, and we believe will give good financial returns, but the general equipment of trunk lines which is advocated by some experts must be considered with caution and study. The steam locomotive is bound to reach further development and motive power officials should bend their energies in this direction as the "iron horse" will be with us for many years to come, and will not be merely on exhibition as a "relic of barbaric ages."

Report on Nova Scotia Railroads.

The report of the Provincial Government Engineer of the province of Nova Scotia for the year ended Sept. 30, 1905, has recently been issued. It deals, not with railroads owned by the general government of Canada which come under the direct control of the Minister of Railways, such as the Intercolonial (467 miles in Nova Scotia), or with privately owned roads declared by Parliament to be for the general benefit of Canada which come under the jurisdiction of the Railway Commission, such as the Dominion Atlantic (231 miles), but with all railroads in the province not falling under one of these two classes. These amount to a total of 490 miles, the longest being the Halifax & South-Western, with 244 miles of line.

At the close of the fiscal year 1904 this road had only 96 miles of line. The increase in its lines has for the first time raised the mileage which falls under the jurisdiction of the province above the mileage of either of the other two classes of roads.

The Halifax & South-Western is the Mackenzie-Mann line. It is still being extended, and when completed as now planned will have about 450 miles of line. At present it connects Halifax and Liverpool, 110.5 miles; Barrington Passage and Yarmouth, 50 miles, and Bridgewater and Middleton, 55 miles, with two branches 7 and 22 miles long respectively.

Work is now nearly finished on a connecting line between Liverpool and Barrington, with track laid part of the way. The Halifax & South-Western during the year under consideration acquired the Halifax & Yarmouth, running from Barrington Passage to Yarmouth, so that on completion of the Liverpool-Barrington section the Mackenzie-Mann interests will have a line from Halifax on the eastern side of the southern part of the Nova Scotia peninsula southwest along the shore to Yarmouth, a short distance northwest of the southern extremity of the peninsula. This, it is expected, will be put in operation late this year. The Mackenzie-Mann system also includes the Inverness Railway, 66 miles.

The Engineer speaks of a new departure in the province, namely, the building of a standard-gage railroad for lumbering purposes by the Springfield Railway Company of Bridgewater. Previously lumber in Nova Scotia has been carried almost altogether by water. When carried by land it was either by teams or for a short distance by a tramway generally with wooden rails. As the value of lumber increases and the business falls into the hands of larger operators it is quite possible that the system which has been initiated by the Davison Lumber Company may be used quite extensively. This company has purchased large tracts of timber land in Lunenburg, Queens and Annapolis counties, and has decided that for the proper operation of their lumber lands a railroad was necessary. In September, 1904, they submitted plans and profiles of a line 4½ miles long, and in November of the same year an extension of 3¼ miles. In August, 1905, they applied for permission to open the road for traffic. The line, while having rather heavier gradients than is desirable on a railroad to carry on a general passenger and freight traffic, is well adapted for the present traffic, and the location is such that these gradients can be improved with small expenditure at any time it is proposed to take up passenger traffic or extend the line. In other respects the railroad is practically up to the standard suitable for carrying on general passenger and freight traffic and reflects the greatest credit on this enterprising company.

The only important survey appears to be that of the Cape Breton Iron, Coal & Railway Company, which has had final surveys under way for a line from Sydney to Louisburg, which is to handle the output from new mining areas to be developed in Cape Breton county.

The table of accidents shows that no passengers were killed during the year, and only one injured, which duplicates the showing of the previous year. Seven employees were killed and 13 injured, against two killed and nine injured the year preceding.

Long Island Railroad.

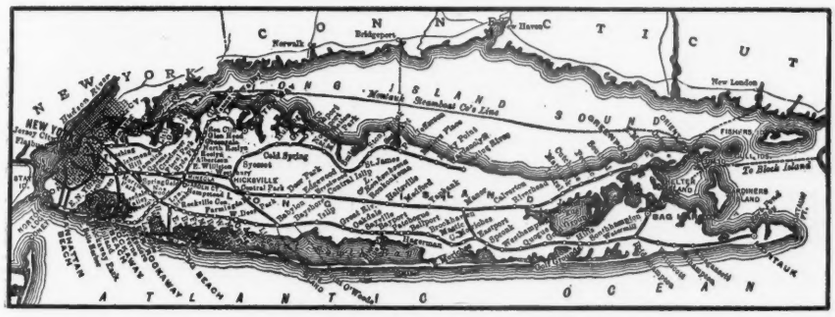
The unusual situation and great potential strength of the Long Island, a railroad confined to an island with connection only at one terminus, and that by car ferries, with other railroads, but with a practical monopoly of a suburban territory of tremendous promise when once made accessible to New York City, has often been commented upon in these columns. In the review of the road's annual report for the year ended June 30, 1904 (*Railroad Gazette*, Dec. 9, 1904), it was shown that while gross earnings had recently largely increased, net earnings from operation had steadily decreased, and instead of a net income profit of over $500,000 in 1902 there was a deficit after charges of over $250,000 two years later. There were pointed out three significant items which helped to bring about the great increase in expenses. These were increased fuel cost, increased car service charges and increased fixed charges due to new securities issued. In considering results for the year at present under review, ended Dec. 31, 1905 (the date of the fiscal year having been changed), it will be interesting to observe the present status of these sources of expense.

So far as gross earnings are concerned, 1905 was by a considerable amount the most prosperous year in the history of the road. They amounted to over $7,800,000, a gain of more than $800,000 over the record figure of the preceding year. Operating expenses, however, showed a gain almost as great, so that net earnings for the year ($1,460,000) were larger by only $81,000 than those of 1904. In fact, the net earnings figure for last year is slightly less than in 1893, when there were 29 miles less operated. As passenger traffic is by far the largest part of the road's business, so the greatest gain in earnings last year came from this source. Freight earnings, however, showed a proportionate increase. Both increases were evidently due to the general prosperity rather than to any particular set of conditions.

Under operating expenses, conducting transportation shows the largest increase. This account includes two of the items already alluded to—fuel and car service. In 1901, with a passenger and freight train mileage of 3,456,305, fuel cost was slightly over $400,000. In 1905, with train mileage (4,284,266) not greatly increased, fuel expense had risen to over $880,000. As explained in 1904, this great increase is due to the necessity which the road is under of using anthracite instead of bituminous coal on most of its locomotives, owing to the fact that so many of its lines enter the limits of Greater New York where the use of hard coal is required. With electrification this condition will be immediately obviated. Again the situation of the Long Island has made operation expensive by

greatly increasing car service charges under the present per diem system. With no connection whatever with other lines at any of its eastern termini, no track connection anywhere with any other railroad, and a heavy passenger service, it is easy to see that the difficulties of promptly getting freight cars off the road are very great. So recently as 1902 the Long Island paid less than $18,000 for car mileage. Last year, car service cost $227,846, a gain of $13,000 over the previous year. Efforts have been made to have the road considered as a switching line, and a schedule of car service charges put in force on that basis, but so far this has not been brought about. For a road situated on an island, with its longest through line only 115 miles long, it would seem only fair that some such arrangement should be made. As it is, the Long Island, with 392 miles of line, has an unfavorable car service balance entirely out of proportion to its size and its freight equipment.

In the third expense mentioned, interest on bonded debt, last year's increase, due to additional bonds issued, was only $86,631, following $169,700 in the six months preceding and $201,200 in the 12 months ended June 30, 1904. The net increase during the year in funded debt was $3,878,000, which is the amount of new capitalization involved in the sale of $6,000,000 4 per cent. refunding mortgage bonds. As the terminal improvements for which these bonds were issued necessitate capital expenditures extending



Long Island Railroad.

through several years from which no revenue can be derived until completion of the improvements, a proportion of the interest has been charged into cost of their construction.

The year's principal charges to capital account were as follows: Atlantic avenue improvement, $780,735; Bay Ridge improvement and elimination of grade crossing in Brooklyn, $67,115; electrification, $3,545,583. There were also charges to capital account for current improvements amounting to $1,104,141 for general maintenance of way betterments, including second, third and fourth tracks, and to $135,856 covering cost of 50 ballast cars, three shifting engines and the steamer "Wyandotte."

The Atlantic avenue improvement in Brooklyn, with the exception of the Flatbush avenue freight and passenger terminals, is finished, and passenger service over the Atlantic division is now operated entirely by electricity. Electrification of the lines in and adjacent to Brooklyn and Queens boroughs is largely finished and electric train service, with 172 regular trains daily, has been in operation since the close of last year between Flatbush avenue, Belmont Park, Woodhaven Junction, Rockaway Park, Hammels, Valley Stream and Far Rockaway and Jamaica and Springfield Junction. The running time between Jamaica and Flatbush avenue has been reduced 7 minutes on express trains and 14 minutes on local trains, and between Flatbush avenue and Rockaway Beach 14 minutes. President Peters reports, however, that electric operation is not as yet on an economical basis. The third rail system in use on the road is described in another column.

The new 1,600 car freight yard one mile east of Jamaica is practically completed. Three other yards, with individual capacities of from 50 to 180 cars were also put in service last year. The rebuilding of the 34th Street ferry terminal on both sides of the East river has steadily progressed. When finished, there will be four new standard slips on the Manhattan side, with a new ferry shed and waiting room. The cost of this improvement will be about $275,000. The new interlocking plant controlling the Long Island City terminal yard is now in service. A new and complete shop for repairing all floating equipment is being built at a cost of $75,000. In addition to these improvements, 11 miles of second track between Babylon and Oakdale are under construction. In order to acquire additional equipment an equipment trust is to be created covering 25 locomotives, 65 standard vestibule passenger cars, 100 gondolas, 100 box cars, two ferry boats, two car floats, one tug boat and 139 steel passenger motor cars and trailers to be used in electric service.

On Nov. 11, 1905, the Glen Cove Railroad, a single phase electric line 3.28 miles long, was put in service by the Long Island Railroad, power for its operation being transmitted from the power house at Long Island City of the Pennsylvania, New York & Long Island Railroad, the company which is building the Pennsylvania's East river tunnel. Another step in acquiring electric properties was taken during the year in the organization of the Long Island Consolidated Electrical Companies as a holding company for securities owned in electric lines promoted or acquired in the interest of the Long Island Railroad. Among the securities which this corporation is to hold are the interests recently acquired in the New York & Long Island Traction Company and in the Long Island Electric Railway. The new company will issue its own obligations against the securities deposited and funds will thus be provided for building additional electric roads to serve as feeders and to protect the revenues of existing steam lines.

As will be recalled, the Long Island Railroad during the year 1905 was signally unfortunate in the loss of two of its Presidents, Mr. W. H. Baldwin, Jr., who died on January 3, and Mr. W. F. Potter, who, having succeeded Mr. Baldwin on January 13, held the position until his death on April 2. To succeed Mr. Potter, Mr. Ralph Peters, previously General Superintendent of the Southwest System of the Pennsylvania Lines West was elected President. The new General Superintendent also came from the Pennsylvania Lines West, so that Pennsylvania methods are now dominant. With less than a full year's term of office, the new management is hardly to be judged by the results presented in the present report, but apparently it is successfully carrying on the work of Mr. Baldwin and Mr. Potter along the lines laid down by them. In spite of a large increase in expenses and a loss of $45,590 from operation of the Montauk Steamboat Co., a charge which did not have to be faced in 1904, the year shows a small net income credit instead of a deficit more than twice as great in the preceding year. Already, in expectation of the completion of the various Long Island tunnels, there is a tremendous real estate boom in that territory, and once the tunnels are completed and close connection made with Manhattan, the Long Island will have a chance to show what may not improbably be remarkable capacities as an earner.

The following statistics show the principal results of the year's operations:

	1905.	1904.
Mileage worked	392	392
Freight earnings	$2,322,344	$2,050,456
Passenger earnings	4,399,624	3,928,427
Express earnings	1,022,036	959,519
Gross earnings	7,824,987	7,021,378
Maint. way and structures	804,738	789,383
Maint. of equipment	957,958	712,994
Conducting transportation.	4,407,560	3,929,270
Operating expenses	6,364,636	5,642,261
Net earnings	1,460,351	1,379,116
Net income	22,529	*54,390

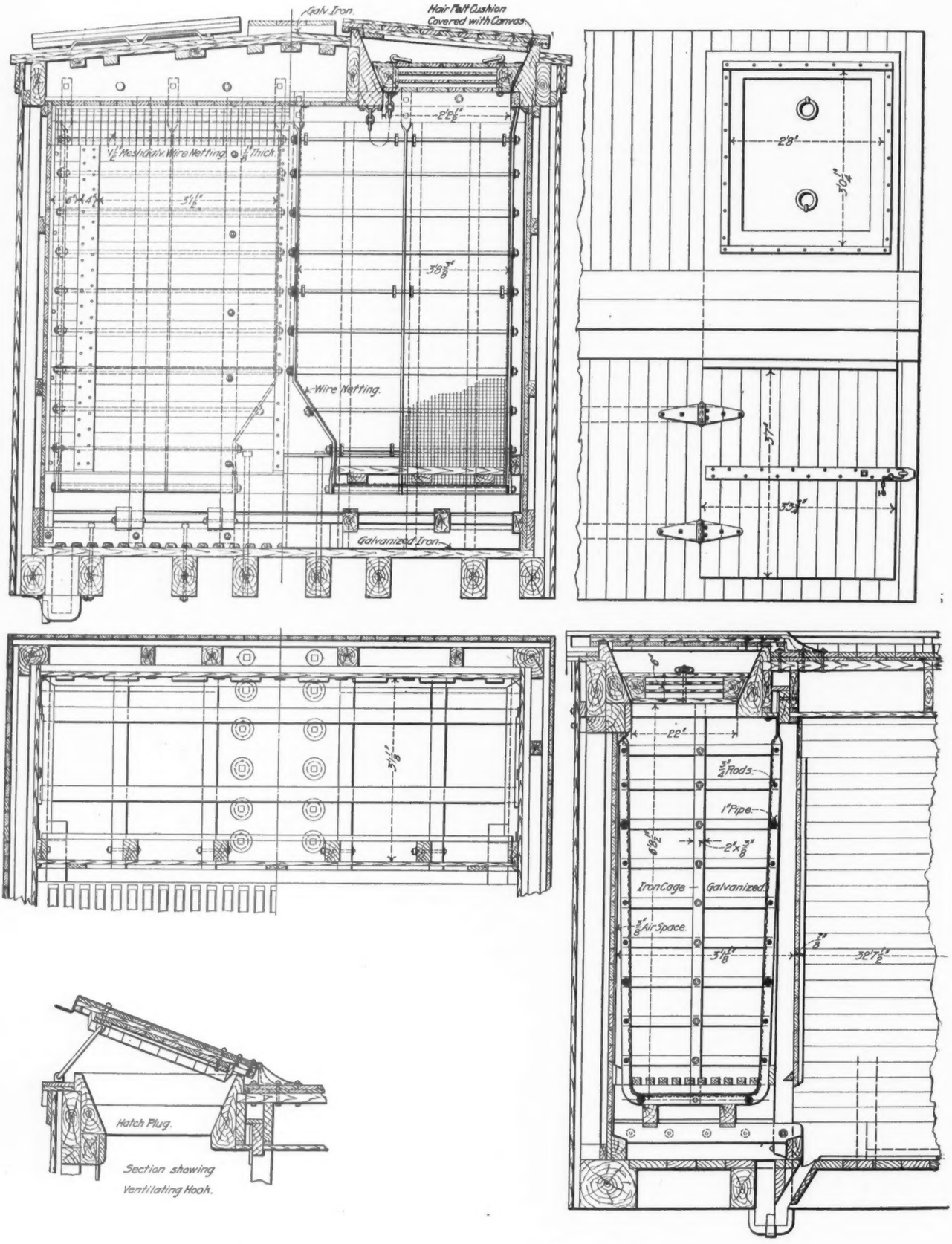
*Deficit.

Baltimore & Ohio Refrigerator Car.

The Baltimore & Ohio class R-4 refrigerator car, of which over 400 are in service, represents the latest development in this class of freight equipment. These cars are 32 ft. 7 in. long, 8 ft. 3 in. wide, and 7 ft. 6 in. high in the clear inside, with a total cubic capacity of 2,015 cu. ft. and a marked capacity of 70,000 lbs., with a weight of 53,300 lbs. They are fitted with steam and air signal pipes so that they may be run in refrigerator express service in passenger trains. The principal features of interest are, of course, the methods of insulation and ventilation and the ice boxes. These are shown in the accompanying drawings.

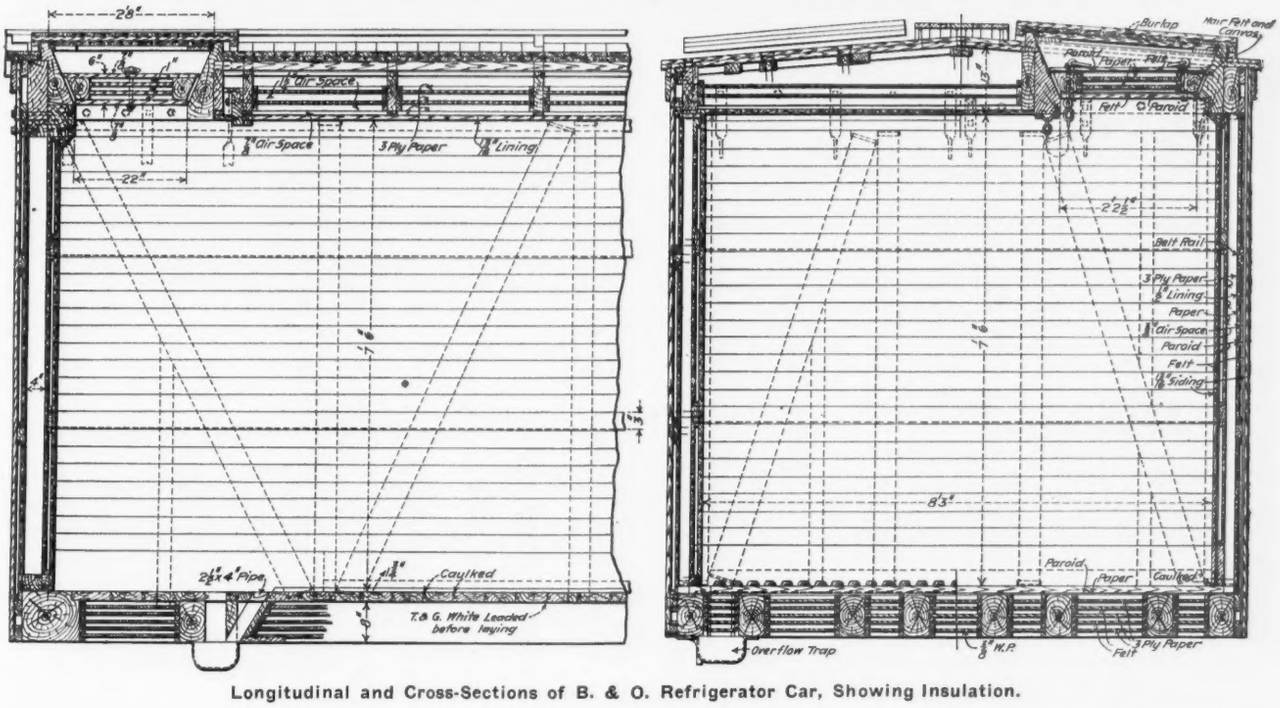
The insulation under the floor consists of five layers of ⅞-in. pine, bass wood or cypress fitted in between the sills and separated by 1-in. air spaces. On top of each layer of boards is a sheet of insulating paper or deadening felt. Above the sills is a layer of half-ply Paroid and one of three-ply Neponset insulating paper, over which the 1¾-in. floor boards, tongued and grooved and white leaded are laid. In the sides the insulation consists of the outside sheathing $^{13}/_{16}$ in. thick, a layer of deadening felt, a layer of half-ply Paroid, ¾-in. air space, layer of Hercules paper, ½-in. white pine lining, 2¼-in. air space, layer of three-ply Neponset paper, ½-in. pine lining, layer of Hercules paper, ¾-in. air space, layer of half-ply Paroid, layer of deadening felt and the inside lining of $^{13}/_{16}$-in. matched bass wood. In the roof is the inside ceiling of $^{13}/_{16}$-in. matched bass wood, layer of three-ply Neponset insulating paper, ⅞-in. air space, layer of paper, 1½-in. air space, ⅜-in. bass wood blind ceiling, layer of paper, 1½-in. air space, ⅜-in. bass wood lining, layer of paper and the air space under the double board roof.

The ice boxes are arranged in pairs at each end behind a ⅞-in. wood bulkhead. They are each 3 ft. 8⅜ in. wide by 2 ft. 7¼ in.

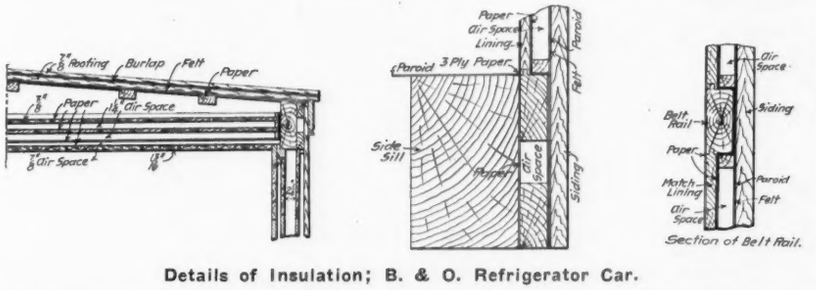


Details of Ice Boxes and Roof Hatches, B. & O. Refrigerator Car.

70,000-lbs. Capacity Refrigerator Car—Baltimore & Ohio.



Longitudinal and Cross-Sections of B. & O. Refrigerator Car, Showing Insulation.



Details of Insulation; B. & O. Refrigerator Car.

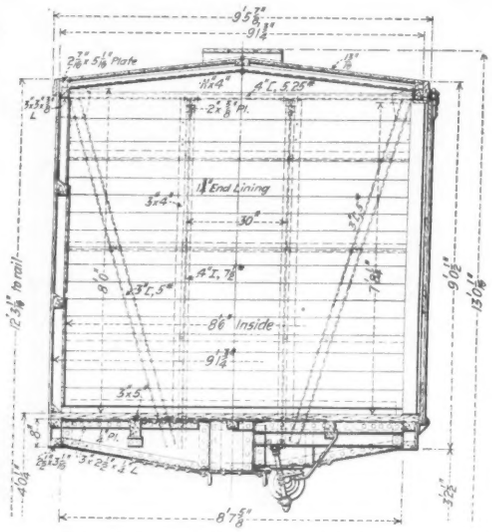
at the top sloping to 2 ft. 1½ in. at the bottom. The baskets are made of ½-in. mesh galvanized iron wire on a frame or cage of ½-in. x 2-in. galvanized iron bars, and rest on two 3-in. x 3¾-in. blocks in the drip pans. One trap of malleable iron is used for the two boxes in each end of the car, the trap being located under the bulkhead just inside the side sill. Drainage from the floor of the car is carried off through the same trap. The entire space inclosing the ice boxes is lined with galvanized sheet iron.

Air enters the boxes through the 7-in. opening above the bulkhead, falls as it cools and leaves through the 10-in. opening below. The upper opening is covered with a screen of ⅛-in. galvanized wire with 1½-in. meshes. When it is desired to use the car, a ventilator car, the hatch plugs are dropped into the ice boxes and hung from a ⅜-in. chain attached to the hatch frame. The roof doors are hinged at the back edge and can be secured in a raised position by a ventilating hook, as shown on the drawings. A circulation of air is thus obtained down through the forward ice box into the car and out through the rear ice box.

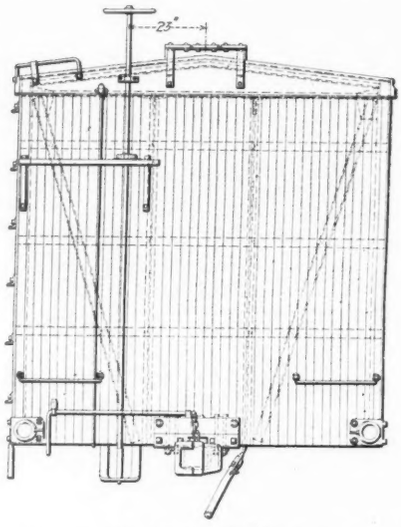
Particular attention has been paid to designing all the parts so that they are accessible and easily removed and replaced in case repairs are needed. The ice boxes, it will be seen, are made with an offset in the center to permit the removal of the draft bolts without taking down the boxes. The cages attached to the car with bolts and the framing for the drip pan supports and bulkhead is entirely separate from the floor or sides so that the boxes may be removed by taking out a small number of bolts and lag screws. We are indebted to Mr. J. E. Muhlfeld, General Superintendent of Motive Power, for the drawings.

Standard 80,000-lb. Box Car for the Rock Island-Frisco System.

At the time that the motive power committee of the Rock Island-Frisco System made its investigations which led to suggestions for standard locomotive equipment (*Railroad Gazette*, Dec. 30, 1904), another committee was engaged in similar work regarding the car equipment. Following the completion of its duties by this latter committee, a standardization committee was formed which is at present engaged in standardizing both passenger and freight car equipment. The standard design for box car has lately been completed, and the drawings are shown herewith. In its report the first committee recommended a capacity of 60,000 lbs. for box, furniture, refrigerator, fruit and stock cars, on the ground that the conditions of traffic did not justify the use of a higher capacity. The committee further recommended the use of steel underframe and steel skeleton superstructure in these cars made of commercial sizes of rolled plates and shapes only, such as can be bought in open market. When the standardization committee came to work up the design for a standard box car it was decided to make it of 40 tons capacity instead of 30 tons, as in the meantime it had been deemed inadvisable to build cars of 30 tons capacity of steel.



Cross-Section of Standard 80,000-lb. Box Car.



End Elevation of Standard 80,000-lb. Box Car.

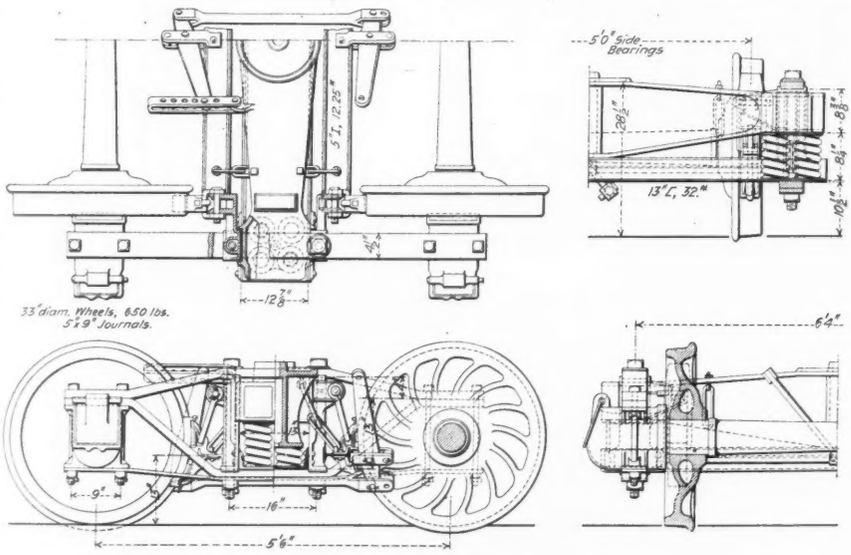
The first committee recommended the working out of the designs with a view to using these steel shapes in such a manner that they would require only punching and shearing without the necessity for heating and working in forms and dies. Also that the center sills and draft rigging be made of uniform strength for all classes, designed on the basis of the stresses imposed in service, without regard to the carrying capacity of the car, since high and low capacity cars are coupled together indiscriminately in making up trains. The steel skeleton superstructure was to be rigidly secured to the underframe and braced in such a manner as to retain its normal shape under all ordinary conditions. The use of a wooden superstructure with steel underframe was disapproved of because of the shrinkage of the former, without accompanying change in the latter; the rods and bolts therefore become loose and the entire superstructure becomes shaky and deformed.

The standard box car is 40 ft. long, 8 ft. 6 in. wide and 8 ft. high to carline inside. It is 44 ft. ⅛ in. face to face of couplers, 9 ft. 3⅜ in. wide over sheathing and 13 ft. $^{1}/_{16}$ in. high from rail to top of running board. The center sills are 15-in., 33-lb. channels, 12⅞ in. back to back. The side sills are 8-in., 11¼-lb. channels, flanges in. Under the door posts, 3 ft. 3 in. each side of the transverse center line, is a transverse member built up of plates and angles and similar in form to the body bolster. The web of this member is ¼-in. plate, the upper and lower edges are stiffened by 3-in. x 2½-in. x ¼-in. angles, and riveted to the latter end and to the lower flanges of the center sills is a ¼-in. plate 5 ft. ⅛ in. long and 9 in. wide at its widest part.

The body bolster construction is shown in detail. The webs and upper plate are ½ in. and the lower reinforcing plate ¾ in. The angles are 3 in. x 3 in. x ⅜ in., except the vertical reinforcing angles over the side bearings, which are 2½ in. x 2½ in. x ¼ in. The connecting plates to center and side sills are ⅜ in. Between center sills is a suitable steel body center-plate casting.

The 4-in. x 8-in. wooden end sill is bolted to a 2⅜-in. plate stiffened top and bottom by 3-in. x 2½-in. x ¼-in. angles. Additional stiffness is given the underframing by 6-in. x 3½-in. x ⅜-in. angles extending from the ends of the body bolsters to near the ends of the center sills.

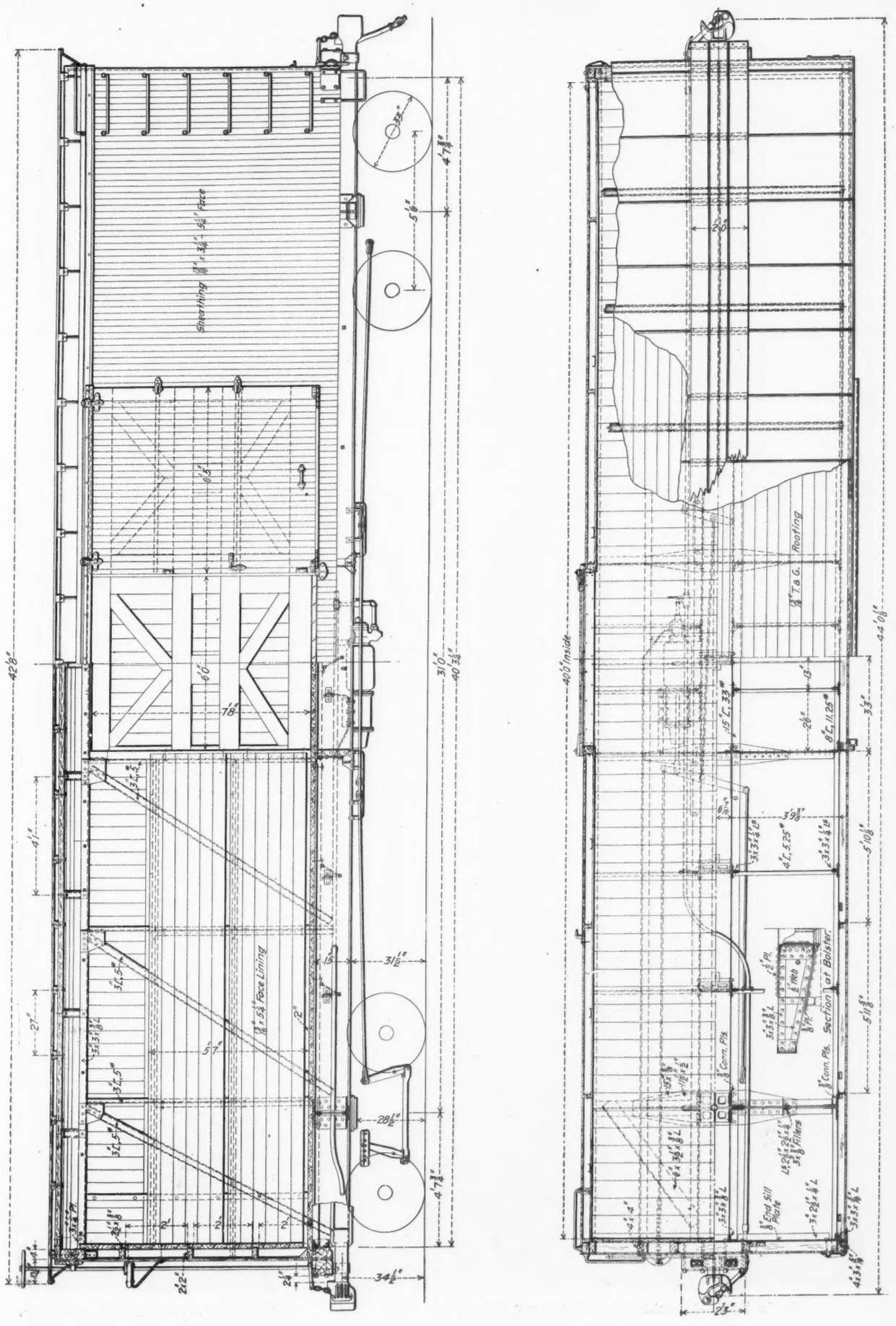
The superstructure is made up of channels, angles and I-beams. The end posts are 4-in., 7½-lb. I-beams, and the corner posts 4-in. x 3-in. x $^{5}/_{16}$-in. angles. The side and door posts, the braces and purlins are 3-in., 5-lb. channels. The top members are 3-in. x 3-in. x ⅜-in. angles on the sides and 4-in., 5¼-lb. channels on the ends. The belt rails are 2½-i. x ⅜-in. flat iron. Longitudinal floor nailing sills, 3 in. x 5 in., midway between center and side sills, rest on 4-in., 5¼-lb. channels secured to the sill webs by angles. There is also a 3½-in. x 2¼-in. center nailing strip between center sills.



Standard 80,000-lb. Arch Bar Truck.

Further details of the wooden construction may be obtained readily by reference to the drawings. The car has but one door in conformity with the committee's recommendation on this point.

The arch-bar type of truck was chosen and is designed to have as few parts as possible. The details of the 40-ton truck are shown. The committee called attention to the fact that many bolsters are fitted with pressed steel or malleable iron center plates having too small bearing surface, which either fail under load or the unit pressure is so great as to cause excessive friction and consequently excessive flange wear on wheels and rails, and derailment on curves. It was recommended that in such cases the center plates be replaced


Sheathing 1⅞" x 3½" - 5½" Face
6'6"
6'0"
78"
42'8"
40'3½"
31'0"
4'7½"
5'6"
41"
27"
5'7"
2"
15"
31½"
28½"
34½"
2½"
2"
2"
2

by cast steel center plates having sufficient bearing area to bring the friction under load within allowable limits. It will be noted that the cast-steel truck bolster has a center bearing of generous proportions. The estimated weight of the car is approximately 40,000 lbs. No cars have been built from the design as yet.

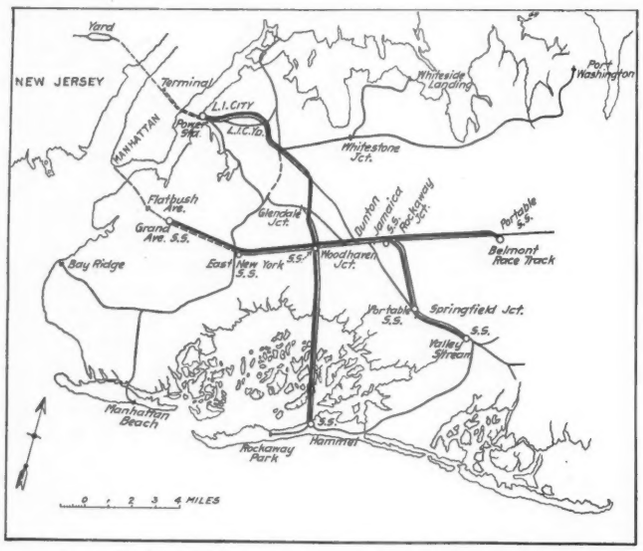
The committee report mentioned the portions of higher capacity cars found to be liable to failure, which for box cars are: Body bolster, truck bolster, draft rigging, door fixtures, brake beams, end framing, end lining and roofs. These features on the accompanying design will therefore be studied with special interest.

We are indebted to Mr. W. A. Nettleton, General Superintendent of Motive Power of the Frisco, for the drawings.

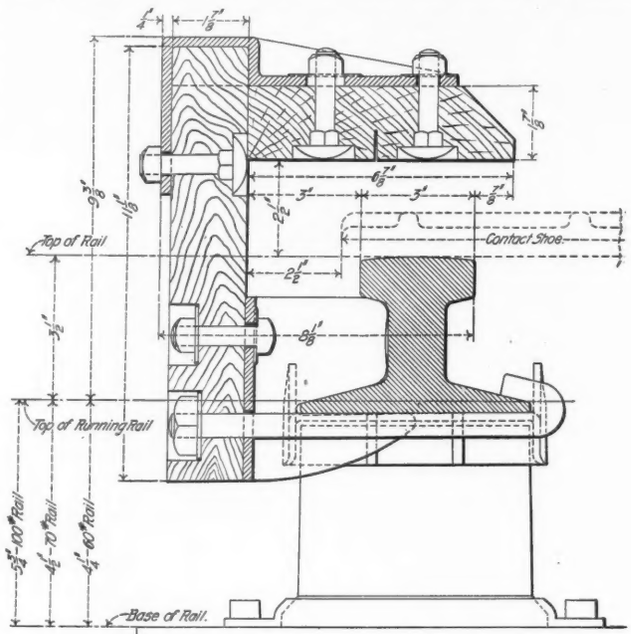
Power Transmission Line and Third Rail System of the Long Island Railroad.

In our issue of November 3, 1905, we published a general description of the electrification of the Long Island Railroad, and in our issues of April 6 and 13, 1906, we printed a full detailed description of the main power station. We are now enabled to show a few illustrations of some of the more important details of the power transmission and third rail systems. Overhead construction for the power transmission line was adopted wherever it was usable, although the impracticability of constructing high-tension overhead transmission lines in thickly populated sections of Brooklyn and Queens required recourse to underground construction in several places. The lengths of the various sections of the transmission lines are as follows: Conduit section of trunk line, power station to Dutchkills street, 1.12 miles; overhead trunk lines, Dutchkills street to Woodhaven Junction, 7.85 miles; conduit section from Woodhaven to East New York, 3.23 miles, and from East New York to Grand avenue, 3.04 miles; Woodhaven to Dunton, 1.7 miles; overhead from Dunton to Rockaway Junction, 1.73 miles; Rockaway Junction to Belmont Park, 3.71 miles; Rockaway Junction to Springfield Junction, 3.35 miles; Springfield Junction to Valley Stream, 2.57 miles; Woodhaven Junction to Hammel, 6.98 miles. The total mileage of conduit lines now in use is 9.09 miles, and that of pole lines 26.19 miles.

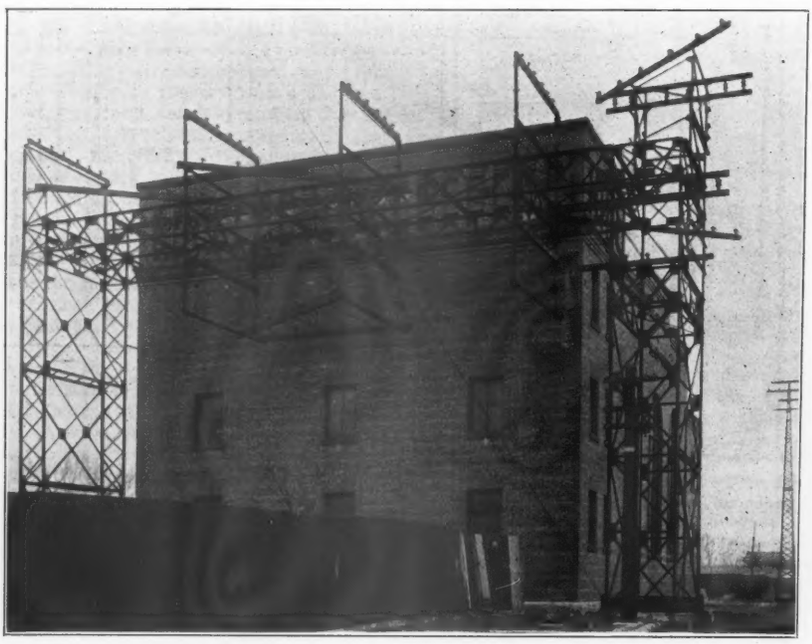
Certain portions of the conduit were especially difficult of construction because of its being situated below the level of the ground water, and special provision had to be made for the drainage of the ducts. The ducts are pitched so as to bring all the drainage into three sumps, from which it is pumped by means of electrically driven submerged centrifugal pumps automatically controlled and discharging into the city sewer system. A cross section of the ducts and manholes on Atlantic avenue is given in the accompanying illustration. The underground high-tension cables are of the three-conductor type, each conductor having a cross section of 250,000 c.m.



Map of Transmission Lines—Long Island Railroad.



Details of Third Rail Guard—Long Island Railroad.



Cable Rack at Rockaway Junction Substation.

Lightning Arrester House at Dunton.

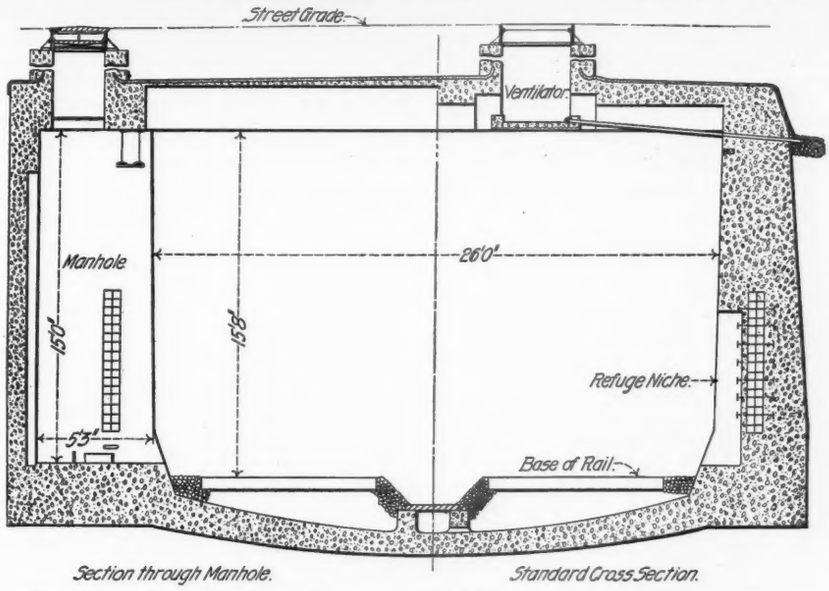
View of Third Rail East of Jamaica.

and being composed of 37 copper wires. The completed cables, including insulation, measure 2⅞ in. outside diameter. There is in all about 25 miles of high-tension underground cable installed, besides .418 miles of armored submarine cable. Wherever the underground cable section of the transmission line is joined up with the overhead system, lightning arresters and choke coils are installed, suitable houses being provided to shelter this apparatus, there being one on the main transmission line at Dutchkills street, Long Island City, and another at Dunton, on the branch line running east of Woodhaven. Smaller houses were also provided for the same purpose at the two drawbridges.

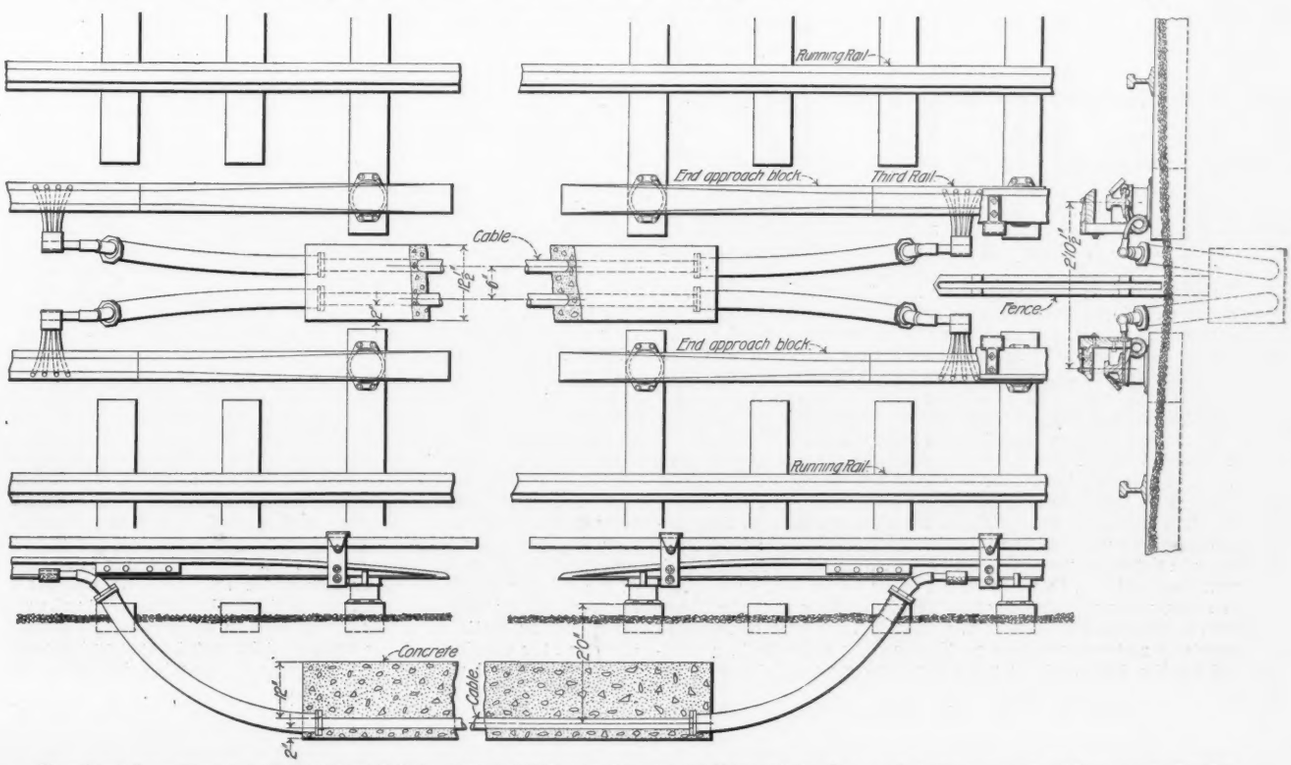
There are two general divisions of the overhead construction—the trunk line between Dutchkills street and Woodhaven Junction and the branch lines between that point and the other outlying sub-stations. The trunk line as well as the more important branch lines are built of steel poles, while the less important branch lines are of wood poles. The ability of the steel pole to act as a lightning rod is turned to advantage, and each pole is thoroughly grounded to a copper plate buried beneath the foundation and connected to one of the anchor bolts by a copper wire.

The wooden poles are of two kinds—chestnut, which is the standard for ordinary work, and creosoted yellow pine, which is used only along the trestle over Jamaica Bay. The creosoted poles are treated with 15 lbs. of dead oil of coal tar per cubic foot of timber. Creosoted poles are all set 15 ft. into the bottom of the bay by means of a water jet. At the Woodhaven and Rockaway Junction sub-stations, special terminal poles or racks are provided to distribute the overhead circuits along the face of the building parallel to the high-tension switching galleries in such a manner that the disposition of the cables after entering the building will be most convenient. The terminal racks at both stations consist, as shown in the illustration, of steel truss bridges supported on lattice steel columns carried on concrete foundations.

The rail used for most of the construction is a modified tee shape weighing 100 lbs. to the yard in 33-ft. lengths. The section is 4 in. high, with a head 3 in. wide, bottom flange 6 in. wide, and web 1½ in. thick. This particular shape was selected because of the limited vertical distance between contact and running rail tops requiring that the upper rail be of as low section as possible to provide maximum insulation distance to tie. In some cases running rails were only 60-lb. section, reducing the available distance from the top of the tie to the top of the third rail to only 7½ in. The



Standard Details of Subway Construction—Atlantic Avenue Improvement.



Standard Arrangement of Third Rail Connecting Cables at Crossings; General Design and Arrangement of Approach Blocks.

section, therefore, is that of heavy rail squeezed out horizontally, with a broad base adapted to reduce overturning. The section, together with the guard, is shown in the accompanying illustration.

The rail is of extra soft steel, as will be seen by the following analysis:

Carbon	0.08	Sulphur	.029
Silicon	.074	Manganese	.022
Phosphorus	.074		

The resistance of the sample in the above analysis is by measurement for a 100-lb. section, equivalent to 1,650,000 c.m. of copper.

All of the main line tracks on the elevated line are provided with this 100-lb. third rail excepting about 7½ miles, which are fitted with 70-lb. standard relaying T-rails. For sidetracking and unimportant spur work, 60-lb. relaying rails are used.

The end approach blocks and incline for lifting the third rail shoes are of cast iron. Two lengths are used—one being 5½ ft. long and used on main line tracks where the shoes must be raised and lowered at high speed, while the other, which is 2½ ft. in length, is used only on spur track and sidings. The approach blocks are attached to the end of the rails by the regular splice plates, and are supported on standard third rail insulators at their outer ends. The general design and arrangement of the approach blocks in position is shown in the illustration. The third rail joints are bonded by laminated copper foot bonds with plug terminals. The third rail is frequently interrupted by highway crossings and switches, and at such places underground cables or jumper cables are used. The accompanying illustration shows the standard method of running and connecting up such cables. They are buried not less than 2 ft. below the surface of the ground, and except where run under public highway crossings a 2-in. plank laid on top constitutes the only protection. At highway crossings, however, a concrete matrix about a foot thick is substituted for the plank in order to insure protection against injury in case the streets are opened by gas or water pipe workmen.

Practically all the line is double-tracked, excepting two stretches which are four-tracked—one on Atlantic avenue between Chestnut street and Woodhaven Junction, and the other running south from Woodhaven Junction as far as the north end of the trestle. About 20 miles of track on Atlantic avenue is laid with 100-lb. T-rails. The remaining portion of the electrified system is laid with various weights of rail, running from 60 to 80 lbs. per yard. The completed overhead line was first put in service on April 27, 1905, and the third rail was first put in service about May 13, 1905. Regular operations began July 26, 1905. The operation of the transmission line and the third rail have been remarkably free from interruptions of whatever nature, and have demonstrated their efficiency as a substantial and reliable transmission system for a suburban railroad on whose regularity of operation thousands of people are daily dependent.

The design and construction of the foregoing transmission system was carried out by Westinghouse, Church, Kerr & Co., engineers for the Long Island Railroad Company, and the entire work was under the direction of Mr. George Gibbs, Chief Engineer of Electric Traction of the Long Island Railroad, subject to the approval of an electrical committee consisting of the chief operating officials of the road, with the President as chairman.

The 50-Ton Box Car as a Standard in Railroad Equipment.

BY W. E. SYMONS.

Two years ago an editorial in the *Railroad Gazette* on the economy of the 50-ton box car contained this statement: "The fact that the Pennsylvania Railroad made this car a standard two years ago is a strong argument in its favor as having an earning capacity greater than the 30 or 40-ton car." An analysis of the real value of 50-ton box cars must take into consideration two important points: Can the greater loads they will carry be obtained? If so, what is the greater carrying capacity during a given period over and above the additional first cost, and the extra cost of hauling the extra dead load due to their weight? In the same article attention was also directed to the fact that "on the Missouri Pacific, after four years of educating the shippers and agents in loading cars to the fullest capacity, the average shipment of general freight per car from 23 of the largest stations on their lines was 11,688 lbs."

In view of the fact that many thousand 50-ton capacity cars have been added to the equipment of our railroads in recent years and many thousands are now under contract or construction for future delivery, it sems not inappropriate to raise the question at this particular time as to whether the results obtained from the use of the 50-ton car in actual service will justify its extended use in all localities as a standard car, in place of the 40 or 30-ton car, or whether these results, when properly analyzed, will not show that the 50-ton car, from a practical or commercial standpoint, can only be regarded as a specialty and confined to a particular class of traffic in a territory where the limits of its usefulness are governed by well determined lines of demarcation.

A proper and intelligent analysis of this subject necessarily involves the collection or compilation of itemized data on the essential factors that have a bearing upon or controlling effect on the relative value of this car as compared to the others above mentioned. Among these most important factors are the following:

(1) First cost of car.
(2) Capacity of car, cubic contents and weight.
(3) Weight of car.
(4) Average load carried in tons.
(5) Conditions which militate against full load.
(6) Cost of maintenance.
(7) Extra cost of hauling extra dead weight when moved with less than full capacity.
(8) Extra cost for maintenance of permanent way, bridges, etc.

The most important items above enumerated, and which are essential to the fair comparison with cars of 30 or 40-ton capacity, can only be obtained by actual experience with the large car under operating conditions and it should be borne in mind that such only tend to show the value of the car in the particular territory where it is in service and the comparisons are being made. Therefore, it would be highly interesting and very valuable to the railroad world, also to the operating officers at this particular time, if they could be favored with a very thorough and complete report of the results obtained by the use of a given number of these cars in comparison with others covering a period of two or three years, furnishing the exact figures and facts, that others who may contemplate the addition of new and heavier equipment may be better able to reach a correct conclusion in the premises, as to the type of car best adapted for the locality through which their lines may run.

Some observations of a general character may serve to emphasize certain points of more or less interest. One of the most prominent railway systems in the West have at present in service over 5,000 50-ton box cars, with steel underframing, 40 ft. long and weighing over 41,000 lbs. These cars, as a rule, are loaded to a point reasonably near their capacity in both directions between Missouri river points and the Pacific Coast, a distance of 1,780 miles, and not infrequently from Chicago or points East, giving a through haul in the latter case of 2,280 miles. This, of course, is what might be termed an unusually favorable condition of service for the 50-ton cars and gives them a place at once among the improved facilities that count for increased net earnings. The average tons per loaded car on this line is 20.18, while the average tons per revenue car is 19.38. The average tons for all cars, loaded and empty, including cabooses, is 14.05. From these figures it can be readily seen that the very creditable tonnage per loaded car of 20.18 is doubtless largely influenced by the use of the 50-ton car in this particular territory. As further evidence of this, let us enumerate some of the various commodities handled at different points on the line and the quantities in percentage of the car capacities which enter into the general average above given. A few of the most commonly known commodities, which form the greater portion or bulk of freight shipments and the percentage of the car capacity utilized in their movement, are as follows:

Brick	95.6	Mill stuff	61.4
Coal	92.7	Oil	97.0
Corn	93.5	Ore, lead, and bullion	102.5
Hay	38.3	Sugar and molasses	80.9
Lumber, ties, etc.	70.4	Wheat	93.1
Merchandise	26.5	Miscellaneous	63.3

From this it is apparent that with the low average per cent. of loading in cars handling hay, merchandise, mill stuff and miscellaneous, the 50-ton box cars have undoubtedly contributed much to the high general average of revenue tons per car. Inversely, it affords excellent proof to the contention made by many, and in which the writer concurs, that there is a special field for the 30-ton car of the American Railway Association dimensions, which the 40 and 50-ton car cannot invade without a positive loss, either direct or indirect to the operating companies; and that field is the one where the last-mentioned commodities predominate and where conditions necessitate their movement in a manner to suit the shipper, regardless of the wish of the carrier. In further support of this view or theory, let us again refer to the results obtained on the Missoui Pacific road, and in commenting on the same it is suggested that, as a general proposition, it is not within the range of possibilities for the carriers to educate the shippers so as to secure the delivery of their traffic for shipment at a time and in a manner that will permit of a prompt and full-carload movement at a specified time of commodities of this character which will compare with the handling of ore, coal, bullion and similar commodities, which are regulated by the train load rather than by the car load and which are offered for shipment at a time and in such quantities as do not require movements of less than the maximum train load. It would seem to the writer not inappropriate to suggest that this is an era of the shipper educating the carrier rather than the carrier educating the shipper and he is inclined to think that the results shown by operating statistics would prove this to be correct. A casual glance at the condition of our equipment in recent years and operating statistics will suggest, he is quite sure, some inquiry as to the cause of certain apparent deficiencies.

In 1903 we had a total of 43,871 locomotives; in 1904 a total of

46,743, an increase of 2,872 engines; 1,585 of these were freight engines, the majority of them consolidation heavy freight engines, in many instances almost twice the tractive power of the freight engines of a few years ago. During the same period we also had added to our freight equipment 38,412 cars, most all of which were above the 60,000 lb. capacity. It is a significant fact, however, that during the year 1904 the average tons per freight engine were only 48,463 as against 51,265 for 1903 and 50,874 for 1902. The ton miles per freight engine showed a corresponding decrease, there being 6,456,846 in 1904 and 6,807,942 in 1903, proving conclusively that notwithstanding the very unusual addition in number and corresponding capacity of freight engines, that less work was performed both by engines and cars. This would seem to warrant the conclusion that a portion at least of this deficiency or very unfortunate waste of tractive power was absorbed in hauling the dead weight of the very heavy cars added to our equipment. These variations or changes in operating results are due, of course, to a combination of many causes, some of which pertain to railroad operation or administration and some of which are commercial and social in their character.

During the past few months the writer has had occasion to analyze certain items entering into general operating results or expenses on several lines and on some of these the 50-ton box car has played quite a prominent part, particularly in localities and under conditions especially adapted for the use of the 30-ton car, weighing from 34,000 to 35,000 lbs. The net revenue tons per train mile hauled on a small road or on a certain division of a large road, where they have quite a large volume of coal, ore, bullion and other heavy commodities suitable for movement in the 50-ton car and also a heavy local freight and merchandise business suitable for a 30-ton car, can be and frequently is reduced to a figure which, in the absence of a thorough analysis of the conditions, would indicate a lack of proper supervision by the adverse effect of the heavy local freight and merchandise trains being largely made up of 50-ton box cars weighing from 40,000 to 46,000 lbs. each, and in many cases having only 10 to 12 tons lading. Such conditions will make a very bad showing for any operating officer, and if viewed on a net ton mile basis only would destroy his reputation, and materially affect the net earnings. Under such a condition there is certainly a special field for the 30-ton car for local and merchandise service and the 50-ton car for the heavier and less bulky commodities of a different character, and any attempt to use the 50-ton car as a common standard under these conditions would be as impractical and expensive as to adopt a heavy consolidation freight engine of 45,000 lbs. tractive power as the standard engine for all kinds of freight service, without exception and with a view of eliminating all other types of engines from the road except the passenger engine.

In England the small car or "goods wagon" has been and is a success, and in such matters as are of purely a commercial or social character and go to influence or govern the size of cars in England, we are, as a nation, following closely in the footsteps of our English brethren, not because it is English, but for the simple reason that we cannot do otherwise. In order that this may be made a little clearer to any who may not be familiar with the conditions, let us briefly analyze the conditions that govern this phase of transportation.

The merchandise, freight or goods traffic out of London or any other commercial center includes quite a volume of business commonly called emergency or rush orders of merchandise of a general character held in stock in large quantities by the wholesale house or jobber, but not carried in sufficient quantities by the local or retail dealer in the smaller cities and country towns to supply the trade between their regular shipments of spring, summer, fall and winter goods or commodities. There are also financial reasons frequently which prevent the small dealer ordering all he might fairly anticipate as his legitimate needs for a certain period; therefore, from many causes unknown to the carrier, shipments of this kind in great numbers are delivered to the freight houses late in the afternoon, frequently with the distinct understanding and pledge on the part of the traffic department that they will be delivered at the home town, possibly 10, 20, 50 or 100 miles distant, at the time of opening of the business houses the next morning. Frequently the shipment only consists of a few hundred pounds. It is placed in the car and when its destination is reached the car is switched or shunted out of the train, which then proceeds, possibly repeating this operation at numerous towns along the line of the road. This, not because the railroad prefers these small hand-basket shipments, but because the shipper requires it and demands it and it must be provided in that manner.

In America such practices were little known years ago, most freight being ordered by mail; and in the sparsely settled districts two weeks to 30 days was considered a very prompt delivery; on the frontier two or three months. But things have changed. The small jobber in the outlying cities and towns, also the country merchant, calls up the wholesale house by long distance telephone without leaving his own office and places his order with the understanding that it is to be delivered at his town during the night or early the next morning. Thousands of such orders are coming in daily to all of the large commercial centers and the different railroads are vying with each other to see which can best serve patrons of this character. These shipments, although insignificant in bulk or revenue to the carrier, are frequently made by patrons whose shipments of a different character amount to a great deal during the year, and in order that they may be moved with promptness and despatch and at an expense that will bear some reasonable ratio to the revenue derived therefrom it is absolutely essential that equipment suitable should be provided. If the 50-ton box car is made a standard by any considerable number of lines these cars will, of necessity, be used in traffic of this character with the result that the net revenue tons per train will be largely reduced without a sufficient corresponding increase in earning capacity of these cars when handling a commodity for which they are especially adapted.

The freight car mileage for 1904 was 14,353,650,056; 31 per cent. of this was empty car mileage, which would indicate that there were many lines operated under a condition where it was almost impossible to secure loading in both directions for their cars. While this is doubtless largely the case in roads that are essentially coal or ore lines, yet much of it is in the agricultural districts where the empty mileage is box car equipment, handling an average of about 15 to 18 tons per revenue car. This would seem to warrant the suggestion, if not the conclusion, that a general utility car substantially built to meet all the physical conditions resulting from interchange service, with minimum dimensions of the American Railway Association's standard box car, of a capacity not exceeding 80,000 lbs. and with the probability that 70,000 lbs. would be more desirable, is not only the more typical, but more desirable commercially, physically and financially, as a common standard for American railroads, than the 50-ton car, although the latter has been made standard on some of the most important trunk lines, and by virtue of the interchange arrangements between American roads is not only in evidence on, but in some localities forms a no small part of the equipment used by, lines which have openly declared in favor of the 60,000 capacity and against the 100,000 capacity car.

It seems rather inconsistent, from a business and commercial standpoint, that large trunk lines should spend enormous sums of money in perfecting their permanent way, shops, yards and other facilities for handling their business, also equally large sums in the purchase of expensive motive power and equipment which is peculiarly adapted to their line and meets with the views of their officers, and then that a large portion of this equipment should be diverted into a class of traffic and on to lines where the conditions are directly opposite to those which prompted its purchase and where the officers in charge hold directly opposite views as to its commercial value as an operating unit and as to the practicability of its use. And while much of this modern heavy equipment is to be found on roads whose officers question its adaptability to the conditions which they have to meet, at the same time a no less conspicuous feature of what might be termed unbusinesslike conditions that result from the interchange of cars is the presence on the large trunk lines which have adopted the modern heavy car of a great number of the small antiquated cars belonging to the lines which do not favor the use of the big car. Many of these small cars were built years ago when the tractive power of our freight engines averaged about 25,000 lbs. The original construction being light, this, together with their age, renders their physical condition such that in some cases they are scarcely safe for service in light trains in local service, and are absolutely dangerous when placed in modern heavy trains handled by modern types of heavy freight engines; dangerous not only to the cars themselves, but in case of accident as a rule they are not only badly damaged, but are the direct or indirect cause of damage to the modern heavier cars with which they are intermixed in train service. The high cost of freight car repairs on some lines can be traced to the retention in service in some cases of light antiquated equipment that should have been retired from service immediately following the advent of the large steel car.

One of the most prominent systems in the country, which has adopted the 50-ton car with steel under-framing as a standard, is to retire this year from service 16,000 of the small antiquated freight cars. Aside from the reduced capacity, together with the increased cost of maintenance of the individual cars which are to be thus retired, it is not unreasonable to suppose that the question of safety in connection with their use along with the large car may have had some bearing in reaching a conclusion in reference to their retirement. It would not seem unreasonable that the Master Car Builders' Association should seriously consider some amendment to, or modification of, the present rules of interchange which, while not restricting any railroad company as to what it should use on its own lines, would establish some reasonable line of demarcation as between what might be considered antiquated and unsafe equipment and what is of such physical condition and character as to meet any and all conditions; and this without in any manner abridging the rights of the owners or without any resulting inconvenience to the shipper, and which would at the same time harmonize with

the spirit which has prompted many of the more progressive roads into making unusual strides in the matter of improved equipment.

All-Electric Interlocking at Council Bluffs.

The Union Pacific has now in course of construction at Council Bluffs a Taylor all-electric interlocking plant, made by the General Railway Signal Company, of Buffalo, with which there will be controlled from a single tower all the switches and signals from the east end of the Missouri river bridge eastward to the Union Pacific Transfer Station. There will be 65 working levers in a 72-lever frame. The average number of daily train movements at the junction is 240, and five switching engines are constantly employed in moving cars from one railroad to another and to and from numerous private sidings.

Fig. 1 shows the arrangement of the tracks, switches, derails and signals, and the wiring, outside of the cabin, for electric locks. The wires for other purposes are carried on the same poles, but are not shown here. Fig. 1 is not drawn to scale, but is approximately correct as to longitudinal proportions except where pieces are cut out, as between signals D 08 and 08. The approximate distances are, beginning at the left or west end of the plan: From D 02 to 02, 2,500 ft.; from 02 to 72, 2,500 ft.; from 72 to 70, 3,000 ft.; from 70 to 23 (dwarf), 775 ft.; from 23 to 69, 750 ft.; from 69 to the cabin, 450 ft. From the cabin to the farthermost switch (58) near signal 70, the distance is 1,865 ft.

The lines north of the cabin constitute two double-track railroads, one of which is used by the Union Pacific and the Chicago & North-Western, and the other by the Rock Island, the Milwaukee and the Wabash, as shown on the drawing. The tracks south of the cabin extending directly east lead to private industries, and those to the southeast to distributing yards and engine houses, and to the main line of the Burlington.

The home signals are all fitted with electric slots, so as to be thrown to the stop position by the action of the track circuit relay as soon as the engine of a train passes the signal. The distant signals are controlled by their home signals and also by circuit breakers which are opened by the home signal on the same post, except No. 72, at which point there is no home semaphore signal. There is a disk, but this is not depended on to operate a circuit breaker. This distant signal has a slot of its own.

In all high-speed tracks the switch levers will be locked by track circuit locking, and mechanical detector bars are to be used only on the yard tracks used for low speeds. In consequence of disturbance in the track from currents leaking from power and street railroad circuits, amounting to as much as five amperes, it was found necessary to use alternating currents for the track circuits. These are used throughout the plant, and for the block signals as far as the Missouri river bridge. The current for the track circuits is delivered from transformers, made by the Union Switch & Signal Company, which take 400 volts from the line, and the relays will be of the type used in the New York subway, made by the same manufacturers.

In Fig. 1 secondaries of transformers are shown connected to track in place of the usual track battery. On the Missouri river bridge an ordinary track battery is used. This is necessary on account of the difficulty of running high-tension wires over the bridge.

The power for this plant is to be supplied by the Omaha Electric Light & Power Company, at 400 volts 60 cycle alternating current, but there will be an emergency a.c. generator in the signal cabin for use in case the power company's line should fail. This will be driven by a gasolene engine.

The main battery for moving the switches and interlocking signals will consist of 55 cells of Electric Storage Battery Company's type E, of 120 ampere hour capacity. This will be charged by a Crocker-Wheeler 125-volt 2-k.w. generator. To charge the storage batteries that are to operate the automatic block signals and the annunciators there will be one Crocker-Wheeler type L 250-volt 2-k.w. generator. These block signal and annunciator batteries will be the Electric Storage Battery Company's type ET, with cells of 36 ampere hour capacity. Of this type there will be double sets, making 252 cells in all. For the track circuits there will be a Fort Wayne 400-volt, 60-cycle, 2-k.w., single-phase, alternating-current generator. This generator will be used only in emergencies, should the power company's line go down or the main transformer burn out. All the generators will be driven by a Westinghouse three-phase, 60-cycle, 5-h.p. motor, type CCL; and the emergency gasolene engine referred to will be a Fairbanks-Morse of 6 h.p.

The resistances in the line circuits for the block signals and annunciators are so arranged that they are all multiples of 1,016 ohms. This was necessary in order to have all the batteries exhaust at the same time. In this way complications in the charging circuit are avoided, as all the batteries can be charged at once. The result is that the batteries consist of from one to four sets of seven cells in series.

Consequently, to provide for a charge and discharge of the line storage battery it was necessary in one place to provide for throwing four sets of cells from series to parallel and from parallel to series, with charge and discharge. The wiring for one of these switchboards is shown in Fig. 3. This switch is used at the signal bridge on which signals 1, 2, 3 and 4 are situated. It has three sets of five-pole, double-throw knife switches, of 15-ampere capacity, mounted on a slate base. These three switches are connected together, and as one lever will throw them all at once, no mistake can be made. This switchboard throws a set of four batteries from parallel discharge to series charge, at the same time that it throws another set of four from series charge to parallel discharge.

The power switchboard consists of three main units—one for the 250-volt line circuit, one for the 125-volt main battery charge circuit, and one for the 400-volt a.c. generator.

The equipment of the switchboard will consist of two d.c. volt meters, two d.c. ammeters, one a.c. volt meter and one a.c. ammeter, all Weston instruments. There will be two sets of ground lamps, one for each d.c. circuit. There will be two no-load cut-outs, one for each d.c. circuit; three rheostats; one three-pole, single-throw knife switch to control the induction motor; one two-pole, single-throw knife switch to control the tower lights; one double-pole, double-throw knife switch to throw the alternating line from the

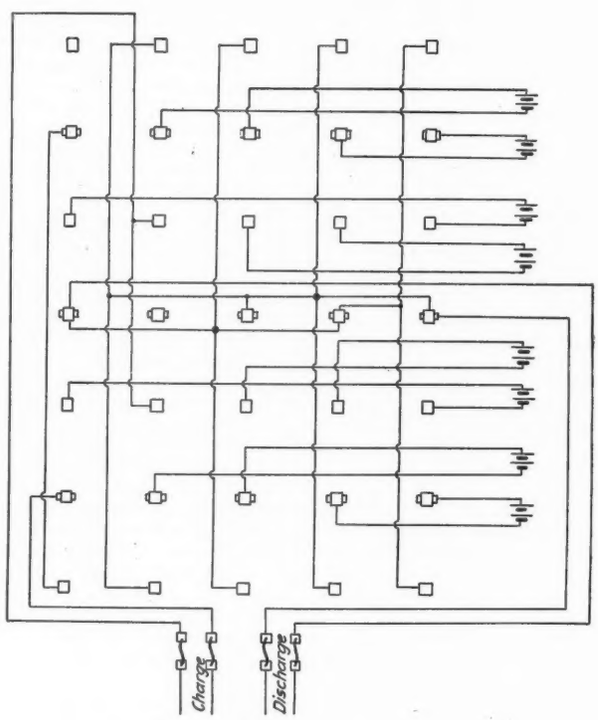


Fig. 3—Wiring of Switch.

power company's transformer to the 400-volt generator; one double-pole, double-throw knife switch so arranged that the main battery can be charged either separately or in series with the local lock battery of six cells.

This switchboard will be made by the General Railway Signal Company. The distributing switchboard will be of the General Railway Signal Company's three cut-out type. Cut-out A, Fig. 2, controls signals 1, 2, 3, 4, 16, 17 and 69, and switches 28, 29, 30, 31, 46, 47, 48 and 49. Cut-out B controls all switches and signals west of and including signals 19 and 20. Cut-out C controls all the rest.

The electric locking may be understood by reference to the wiring on Fig. 1, and to Fig. 2, which shows the wiring in the cabin. As there are home and distant signals on the same posts, the approach locking of one section overlaps the detector locking of the next one. The working of the electric locking may be understood from a description of one circuit. For instance, the eastbound approach locking at the extreme west end operates as follows: Suppose a train to enter the section of track marked A, the armature of relay No. 6 would drop, and thereby open the circuit through its points so as to de-energize annunciator No. 6 in the tower (Fig. 2). Annunciator No. 6 controls high-tension relay No. 7 through its front point and wire a, b, c, d. The circuit for high-tension relay No. 7 also goes through the front point of annunciator No. 7. These two front points are bridged by a circuit breaker on the lever of distant signal No. 72, so that, although the points of either of these annunciators may be open, high-tension relay No. 7 is not affected

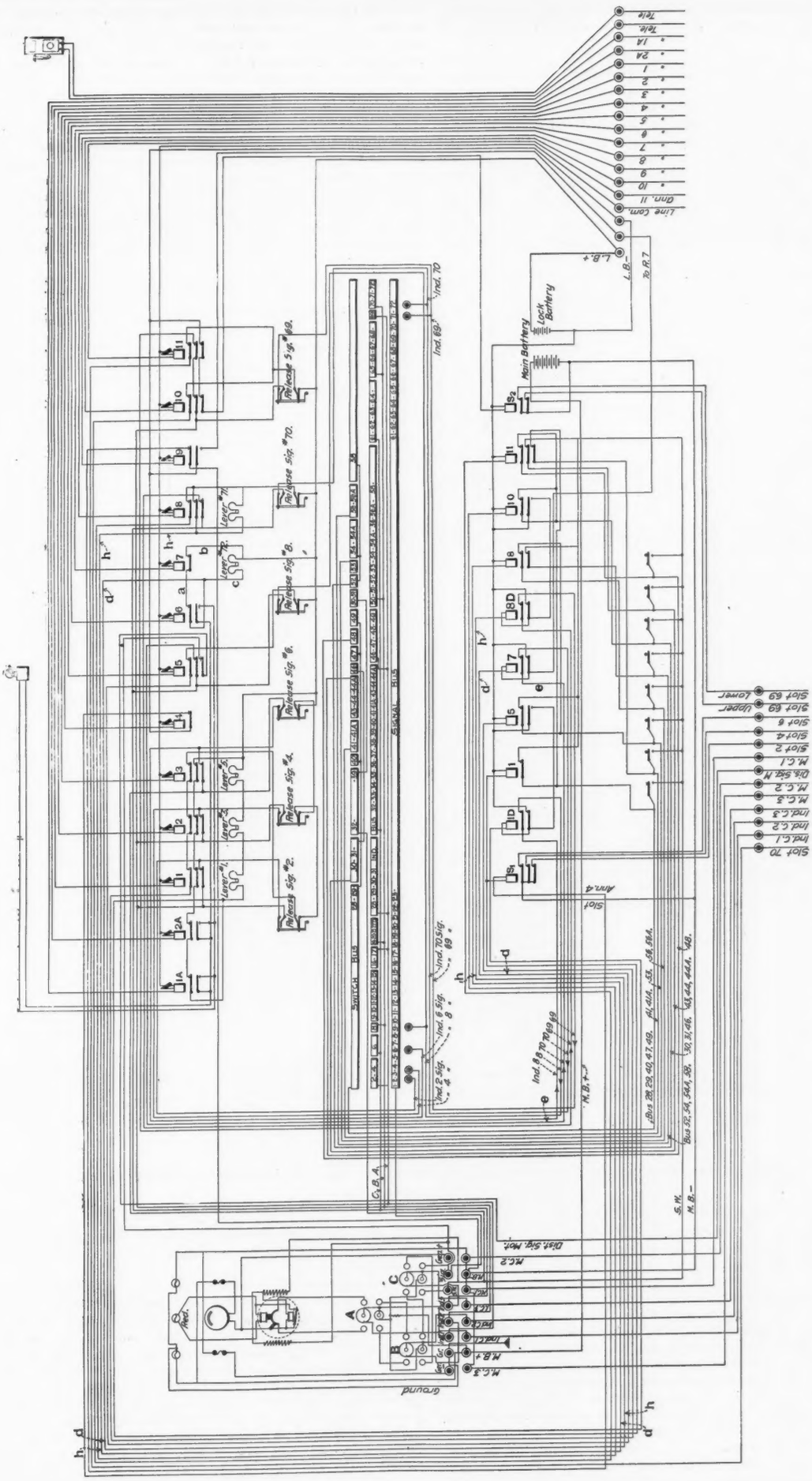
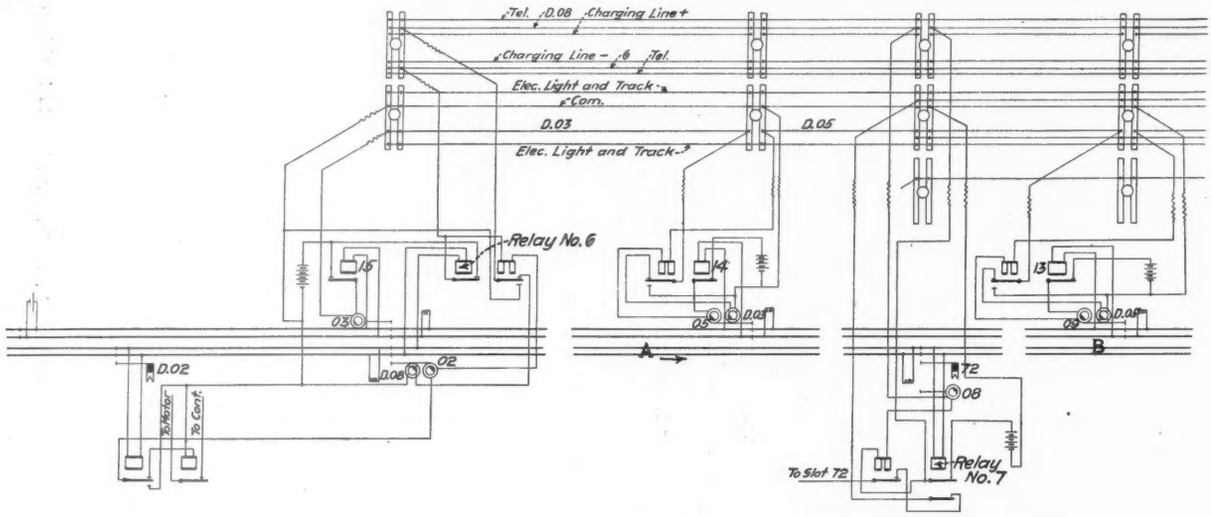


Fig. 2—All-Electric Interlocking at Council Bluffs, Iowa, Union Pacific Railroad—Wiring in Cabin for Electric Locking.

The wires in this drawing referred to in the description are those connecting annunciators 7 and 8 in the upper part of the drawing with electro magnets 7 and 8D in the lower part. The first mentioned may be traced by the letters a, b, c, d. A train passing eastward opens annunciator 6; and high-tension relay 7 (wire a, b, c, d). This circuit is effective only when lever 72 is reversed; Relay 7, open, breaks the indication to signal 70, thus keeping 70 immovable while 72 is off.

unless lever 72 is reversed. But, supposing lever 72 reversed (signal 72 cleared), a train entering section A will drop the armature of high-tension relay No. 7, which will break the indication circuit of signal No. 70. As signal No. 70 must have been cleared before signal 72 could be cleared, it is readily seen that, under the above conditions, it will be impossible to restore lever 70 to the normal position while a train is in section A B—that is, between the distant and the home signal—for the indication cannot be received. When a train has passed signal 70, track relay No. 8 drops its armature, thereby de-energizing annunciator No. 8 in the tower. Annunciator No. 8 controls high-tension relay No. 8 directly through a front point. High-tension relay No. 8 controls through its front point the control or operating circuits of switches Nos. 58, 56, 56A, 54, 54A and 52; so that when a train is on the rails forming the circuit between signal No. 70 and the back-up dwarf signal No. 23, the restored on section No. 10, which is shown on the plan by letter D; so that when a train has passed signal No. 69 it is possible to make reverse movements. But while a train is in section No. 9 (C) it is impossible to clear signal No. 70, as the slot circuit for this signal runs through the points of the relays of sections B and C.

The screw hand releases operate as follows: The circuit for each high-tension relay controlled by an annunciator in a home signal track circuit is taken through a normally closed contact on a hand release. Each hand release has also a normally open contact so connected as to cut out all breaks in the indication circuit of its home signal should the contact be closed. Therefore, the first turn of a hand release will break the circuit of a high-tension relay controlling the switches in the route so that they cannot be moved; and the last turn will shunt out all breaks in the home signal indication circuit so that the return current can operate the indica-



Wires with numbers only are for control of corresponding annunciators or block signals.
Ch + = Positive charging line.
Ch — = Negative charging line.
Com. = Line common.
Tel. = Telephone.
Cont. Sig. 72 = Control circuit for signal 72.
Elec. = 400 v. electric light and track circuit primary feed wires.

Dis. Sig. Motor = Positive wire to operate motor of distant signal No. D 09 controlled by the signalman.

M. C. = Main power common. That is, the 110 v. common for the interlocking functions.

Slot 69 up = Slot of upper arm of signal 69.

Slot 69 low = Slot of lower arm of signal 69.

Ch. feed = Feeder for charging circuit. This circuit charges the block signal and annunciator storage batteries.

Signal D 02 is controlled from station A in the Omaha passenger yard.

Though only one battery is shown at each location, there are two sets, one on charge and the other on discharge.

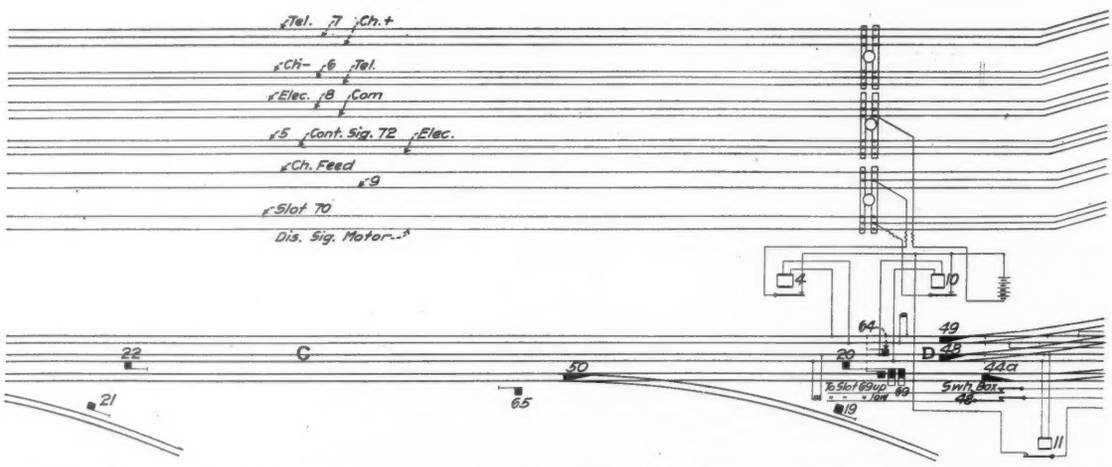


Fig. 1—Electric Locking Circuits of Interlocked Switches and Signals on the Union Pacific at Council Bluffs, Iowa.—Continued on opposite page.

The four parts of this diagram are to be read from left to right across both pages, the western end of the yard being at the top of this page.

power is shut off from all switches and derails in this circuit, and they cannot be moved until the train has passed out. Also, annunciator No. 8 controls through a front point, parallel with the circuit breaker on lever 71, high-tension relay No. 8D (through wire h). No. 8D controls, through its front point, indication circuit of signal No. 69; so that, when a train passes signal No. 70 with distant signal No. 71 clear, it is impossible to restore signal No. 69 to the normal position while the train is in this circuit. High-tension relays No. 7 and No. 8D are stick relays; that is to say, they break their own circuit through a front point. The restoring point for No. 7 is track section No. 9, which is shown on the plan by the letter C. Consequently, when a train enters section No. 9, high-tension relay No. 7 is restored, and it is possible to return signal No. 70 to the normal position, thereby allowing reverse (westbound) movements to be made on this track past signal No. 23. No. 8D is tion magnets. Now, as the switches in the route cannot be moved with the screw hand release in this position, the signalman is obliged to restore it.

All the rest of the electric locking in this plant works in the same manner. That is to say, the approach locking does not operate unless the train approaches the distant signal with the distant signal clear. If it is clear, it is impossible to restore the home signal lever to the full normal position until the train has passed the home signal itself or the first back-up dwarf signal in the route. It will be seen by reference to the plan that the approach section for the double signals 3 and 4 on the North-Western and signals 1 and 2 on the Rock Island extend out beyond the interlocking limits to points E and F, which are approximately 1,000 ft. back of the signals. All slot circuits are taken through switch-boxes on all facing point switches in the route, and where there are two arms

the signals are selected by means of the slots. The signal common wire is not broken through the switch-boxes.

The double-arm signals, where they have a home and a distant blade, are a combination type. The home arm is the new General Railway Signal Company's enclosed mechanism signal, using the vertical motor (described in the *Railroad Gazette* July 14, 1905, page 42). The distant arm is operated by one of the old-style Taylor motors clamped on the post, with a rod outside the post.

The disk signals shown on the drawing are Hall automatic block signals, which have been in service at this point for a number of years.

For the foregoing information we are indebted to Signal Engineer J. C. Young and to W. H. Arkenburg, who until recently was chief draftsman and who designed the electrical features of the plant. Mr. Arkenburg's arangement of electric locking was described in a recent letter to the *Railroad Gazette*, and also in a paper which was read before the Railway Signal Association at its meeting in New York City last month.

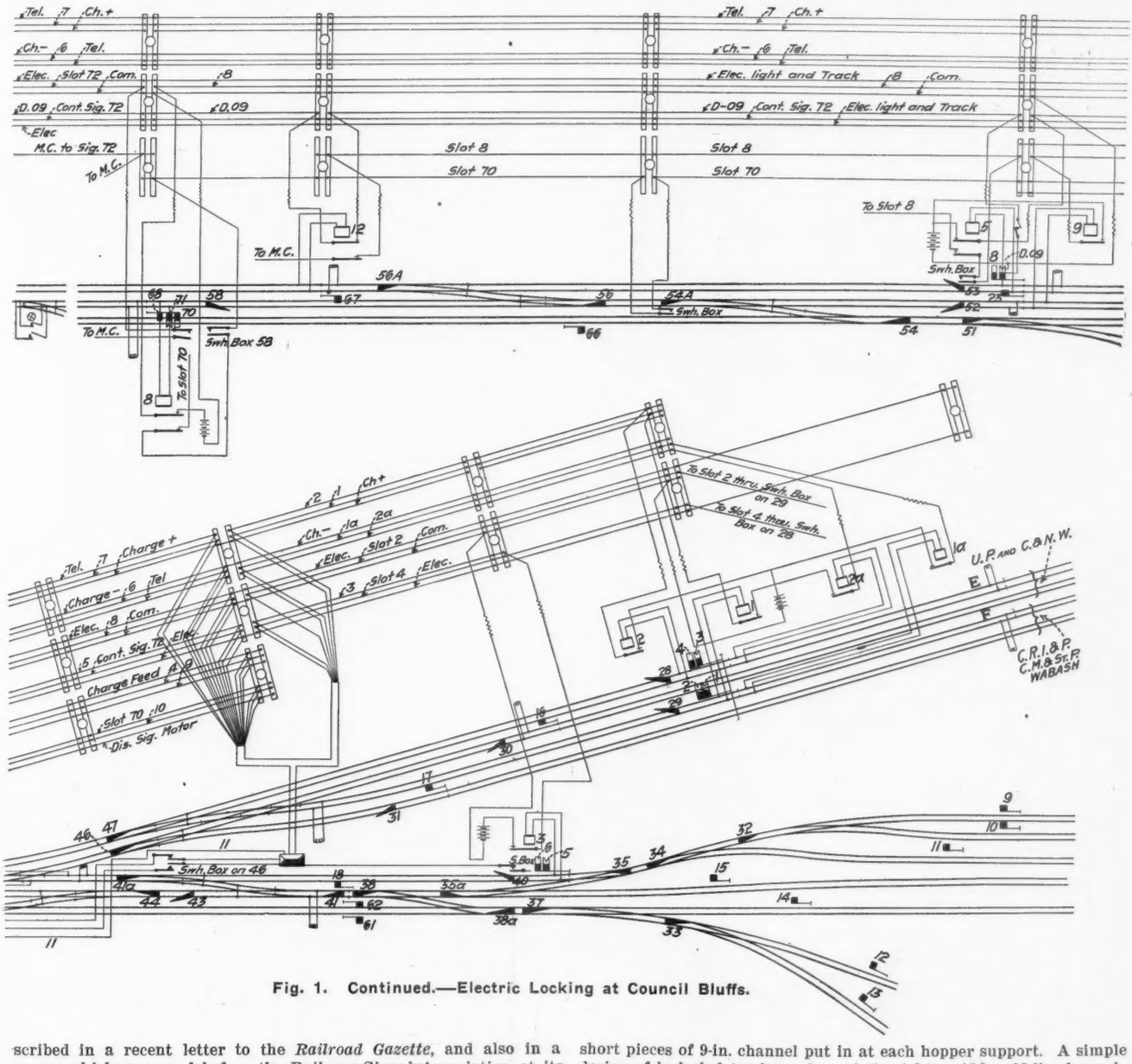


Fig. 1. Continued.—Electric Locking at Council Bluffs.

Phosphate Cars for the Atlantic Coast Line.

The Atlantic Coast Line has recently received from the Middletown Car Works 75 phosphate cars built from the designs of Mr. R. E. Smith, General Superintendent of Motive Power. The phosphate rock which occurs in large beds in South Carolina is an excellent natural fertilizer and the Atlantic Coast Line handles a large tonnage over its lines. The cars used in this traffic are a combination of a box car and a center dump hopper car. They are 38 ft. 8 in. long over end sills and 31 ft. 9⅜ in. long inside of body, and have a capacity of 80,000 lbs.

The underframe is made up of four longitudinal sills, each 15-in., 33-lb. channels, with wooden end sills supported on a ½-in. x 3-in. x 5-in. bracket angle riveted to the ends of the longitudinals. The center sills are spaced 9½ in. apart back to back, and are separated by short pieces of 9-in. channel put in at each hopper support. A simple design of body bolster is used consisting of two 15-in., 33-lb. channels with flanges out, spaced 10 in apart. A ½-in. top cover plate is riveted to the top flanges and the bottom of the box section is formed by a 10-in., 15-lb. channel riveted in between the two heavy channels. The bolster is built up around the center sills, which are continuous from end sill to end sill, by cutting away the flanges of the bolster channels and fitting up the webs tight against the sill webs.

The hopper floor slopes from the ends and sides to the five long and narrow hopper doors under the center sills. The floor is made up of 1¾-in. planks and has a slope of about 48 deg. from the horizontal. The sides are supported at the top by the wooden sill on top of the channel side sill and at the bottom by two ¼-in. x 3-in. x 3-in. angles parallel to the door openings. At the junction of the drop doors plate cross-bearers or hopper supports ⅜-in. x 12-in. are

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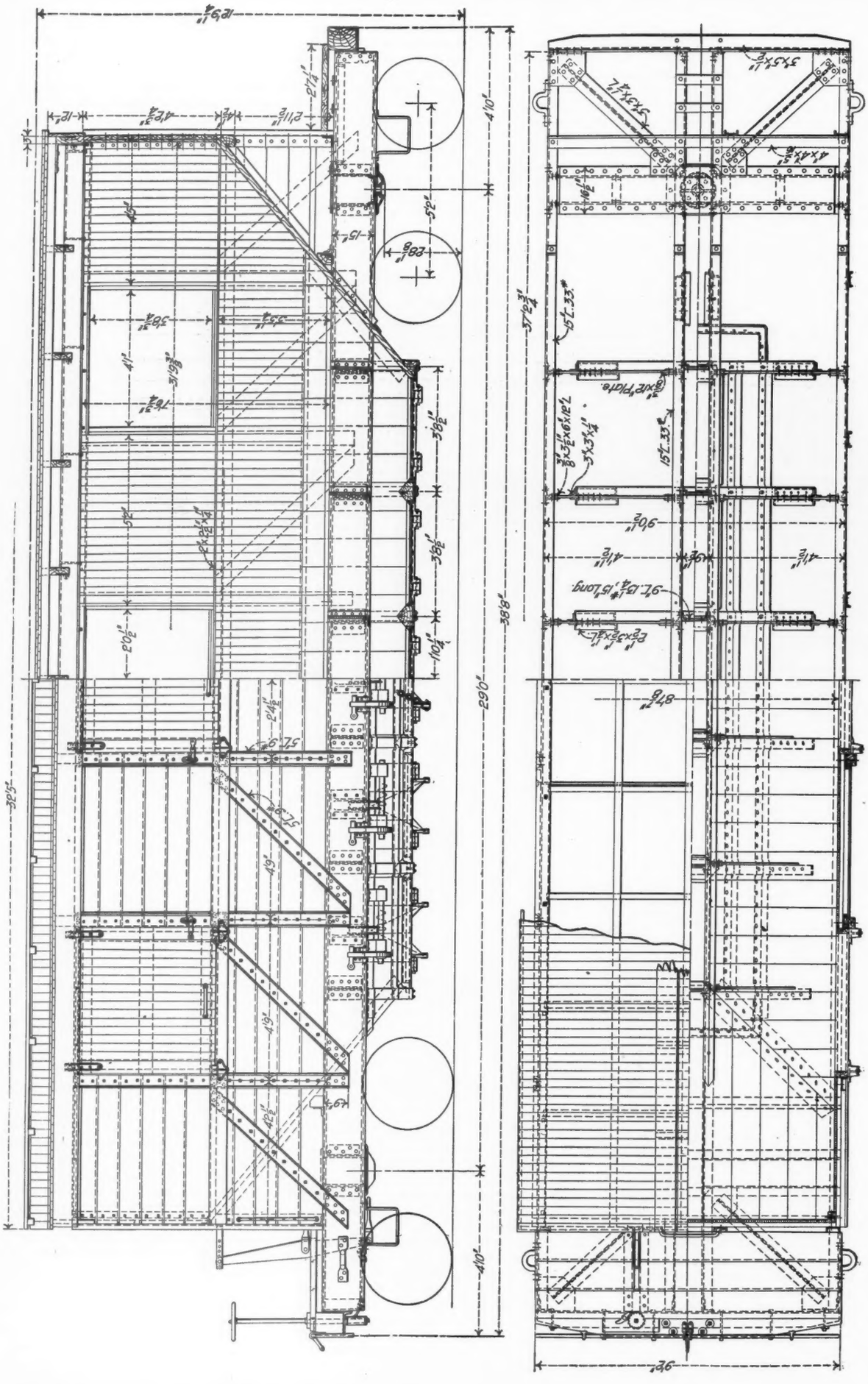
The capacity of Russian freight cars has been increased 20 per cent. without the intervention of any new construction, but simply by the order of the Ministry of Transportation that the standard freight car, heretofore limited to a load of 750 poods, hereafter may carry 900 poods. This short and easy method is not altogether unfamiliar in this country; where in the early days of increasing car capacity it was known as the "paint-brush method," and consisted in changing the figures after "capacity" on the sides of a car. It is not many years ago that the permissible carload in Russia was increased from 600 to 750 poods; but then some strengthening of the springs was required.



Plan and Side Elevation of 80,000-lb. Phosphate Car, Atlantic Coast Line.

riveted across between the side and center sills. These support 3-in. x ¾-in. iron straps which pass under the center sills and support the floor angles as well as the hopper door frames.

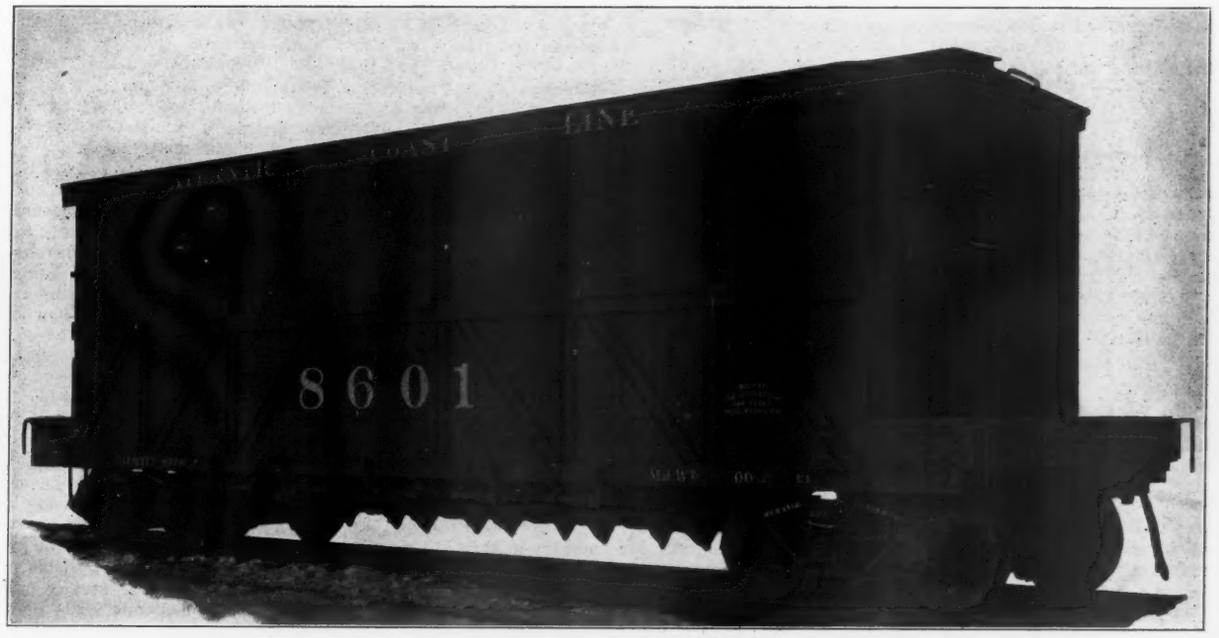
There are five hopper doors having openings 3 ft. x 11 in. These openings are closed by iron doors hinged to the door frame along one side. Two deep lugs are cast on the doors opposite to the hinges to which the winding chains are attached. Two chains are used to each door, fastened to a ring to which the single winding chain is also attached. This single chain passes over a large sheave carried in a bracket riveted to the inside of the side sill and down to the winding shaft mounted on the bottom flange of the side sill. The center sills and door frame castings are capped with triangular blocks so that none of the load will lodge on them.

Above the side sills and below the belt rail the body is built like a gondola with longitudinal side planks bolted to a trussed side frame of 5-in. 9-lb. channels. The posts in this frame are carried up to the plate, but the braces extend up only to the ¼-in. x 2-in. x 2½-in. angle girth. In the middle panel the brace is omitted.

Above the belt rail are three door openings 3 ft. 8¾ in. x 4 ft. 1 in., closed by overhung sliding doors fitted with seal locks as in an ordinary box car. These doors are used for loading the cars from platforms. The roof is made of two layers of boards with a layer of Armitage three-ply plastic roofing paper between layers. Inside lining, $^{13}/_{16}$-in. thick, is put on the sides and ends from the floor to the plate.

The brake cylinder, triple valve and detached auxiliary reservoir are mounted above the sills under the end slope at one end of the car. The cylinder lever is vertical and works in a fulcrum attached to the end girth.

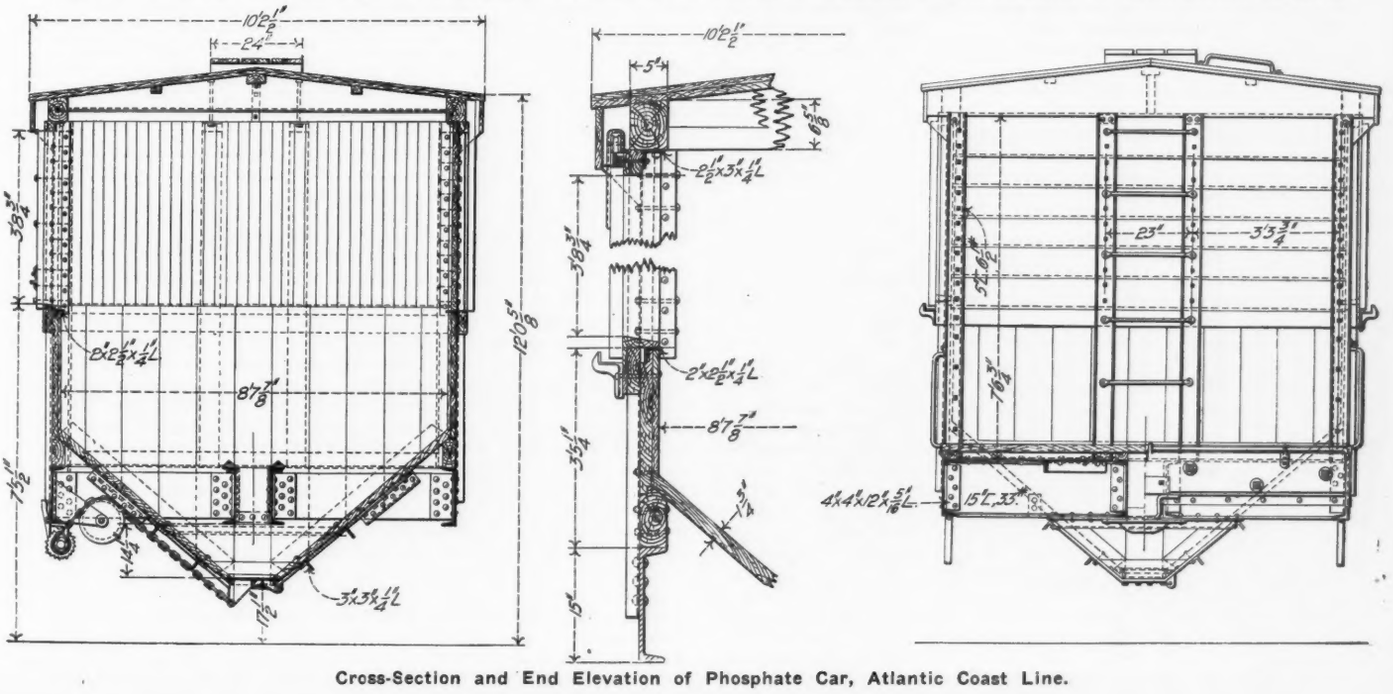
We are indebted to Mr. George I. King, Vice-President and General Manager, Middletown Car Works, for the illustrations.



40-ton Phosphate Car, Atlantic Coast Line.

New Railroad Laws in New York.

The Legislature of New York has passed this year two general laws affecting railroads, in addition to the Elsberg bill and two others having to do mainly with rapid transit in New York city. The most important general law is that which was introduced by Senator Barnes, extending the liability of railroads for injuries to employees. By this law any employee suing a railroad or a receiver for personal injury arising from the negligence of the corporation, the receiver, or any officer or employee, shall have the same rights and remedies as are now allowed, and, in addition, it shall be held that other employees entrusted with authority of superintendence, control or command, or with authority to direct another employee



Cross-Section and End Elevation of Phosphate Car, Atlantic Coast Line.

in the performance of duty, or having physical control or direction of the movements of a signal, switch, engine, car, train or telegraph office, shall be deemed vice-principals and not fellow servants. If an employee is injured by a defect in machinery, cars, engines, attachments, etc., when such defect could have been discovered by the employer by reasonable care, tests or inspections, the employer shall be deemed to have had knowledge of such defect; and proof of the defect shall be prima facie evidence of negligence of the employer. This law runs in favor of executors and administrators in case of a deceased employee; it does not affect actions now existing; and no contract between the employer and employee shall limit liability.

The other law is Chapter 380, amending the railroad police law so that the Governor may appoint special railroad policemen for service at any place (limitation to stations and steamers abolished).

An act regulating demurrage and requiring reciprocal demurrage was passed but was vetoed by the Governor as unconstitutional.

The Chilled Car Wheel from a Manufacturer's Standpoint.

BY P. H. GRIFFIN,
New York Car Wheel Co.

The chilled car wheel situation at the present time is not encouraging. Prices paid for wheels are lower in proportion to the cost of material and labor than they were last year, and present conditions of guarantee are likely to be made more, instead of less exacting. The wheel makers presented the question of guarantee at the Manhattan Beach Convention of the Master Car Builders' Association last June and made clear the impossible nature of present practice. A committee of the Association was appointed to consider the subject and no doubt a report will be made at the convention next week.

The wheel makers' report of last year was the result of careful investigation of the whole subject, and was made after conferences extending over a period of six months, at which every wheel foundry in the country was represented. As any change in present conditions of guarantee must be accepted by the railroads the wheel makers themselves can accomplish nothing beyond presenting for the consideration by the railroads, recommendations which from the standpoint of the makers would improve the wheel situation. Railroad officers, however, generally look upon the solution of the chilled wheel problem as one for which the wheel makers are responsible. The fact is, however, that the railroads themselves are the sole parties to determine the price paid for wheels, and therefore the quality of wheel which is furnished. The conditions attending the manufacture and use of chilled wheels have changed radically during the last eight years, and prices and guarantees which may have been reasonable a few years ago are most unreasonable now. The severity of wheel service has more than doubled in the past five years on account of the increase in loads carried. The net price per pound paid, however, is lower now than then, and the length of service for which guarantees are demanded has been increased instead of being decreased. The conditions under which guarantees are now enforced make the cost per wheel to the manufacturer greater than ever before. Some years ago a mileage guarantee of three or four years' service was considered ample, and the wheel maker was allowed to examine wheels removed from service on account of defects due to manufacture to ascertain the justice of claims for replacement. Now many railroad companies retain possession of wheels on which replacement is demanded and a bill is rendered against the wheel maker of $2 per wheel for the cost of such replacement. In some cases, wheel makers are not allowed to inspect such wheels and have no knowledge of the cause of failure. This practice may be convenient for the railroads and may avoid discussions as to whether failures are due to conditions of manufacture or not, but the injustice of it is apparent.

A few years ago, certain tests to determine the strength of wheels and depth of chill were imposed by one or two railroads using large numbers of wheels, and these tests were gradually adopted from time to time by others. It was the intention of these tests to determine the quality of wheels offered, and by testing representative wheels. To accept or reject certain lots of wheels. Service guarantees were not demanded; the wheels having been accepted as suitable for service under the tests, it was considered fair for the wheel maker to be relieved from further responsibility. Some railroads soon began to adopt the practice of imposing the tests referred to and also requiring a service guarantee. As the demands of service became more severe the severity of these tests was increased from time to time, until now it is difficult to make wheels which will stand both the tests and the service imposed. Wheels can be made which will do one thing or the other, but, at some prices paid, wheels cannot be made which will properly do both. The tests require wheels to resist extreme strains never developed in service, and the wheel maker must make a constant effort to turn out wheels to stand the test in order that any may be sold, regardless of whether they will stand the service or not.

It is of vital importance to the railroads themselves that wheel makers should be allowed to examine wheels for which claims are made under the guarantee of failure in service. The increasing load carried by the wheels and the increase in speed of trains are developing new causes of failure and intensifying others that were not so important a few years ago. If wheel makers have no opportunity to investigate failures and, through the knowledge gained by such investigations, of providing the means of overcoming the particular causes of failure, it is evident that the railroads will be the great sufferers. When a wheel fails in service, whether from defects due to manufacture or from those that arise from some condition of service, the wheel maker may be called upon to stand a charge of $2, or to replace the wheel which failed; but there is no such limit for the railroad company, a broken wheel may involve the loss of life and property. For this reason alone the railroads should invite every means of providing against such a contingency, even if it does involve some trouble in the matter of wheel inspections and adjustments of claims.

It has been asserted by some that the chilled car wheel has reached the limit of its capacity and that something must be found to take its place. No doubt some railroads that are getting just the cheap wheels that they pay for may believe that it will be necessary to find something better, but it is doubtful if the great majority of railroads will abandon the most economical and serviceable article of railroad equipment because it cannot be made cheaper and cheaper from year to year. The difference between the cost of good and poor wheels is so little that the remedy for the trouble now existing would be quickly found if the railroads would abandon the idea that it is of vital importance to save a little money in the purchase of car wheels at the cost of losing large sums in service results. Until the railroads are ready to meet this additional expense in the beginning and to abandon the idea that guarantee requirements should be increased from year to year, instead of being decreased in proportion to the increase in load and speed, the necessary improvement cannot be obtained. The chilled cast-iron car wheel, properly made, is fully equal to any present service requirements. The railroads that have not been carried away with the idea of buying wheels regardless of cost and have conscientiously encouraged the improvement of the chilled wheel to withstand the service under 50-ton cars have demonstrated the capacity of such wheels. There are many thousands of wheels in service under such cars which have been in use quite long enough to conclusively prove their suitability and safety. They were made under conditions of price and guarantee, however, that enabled the wheel makers to turn out a really good wheel. To sum the whole matter up, either the most important thing is to save every possible penny in the purchase of chilled wheels regardless of service results, or to obtain wheels that are equal to the demands made on them at a reasonable price that would enable the successful manufacture of such wheels.

It serves no purpose to equip passenger trains with every device and improvement that can add to comfort and safety and to run them closely following freight trains on the same track, or on adjacent tracks used by freight trains, when the latter are equipped with appliances that are unsafe. The constant effort to reduce the time interval between trains and to increase the speed makes the danger of accidents from wrecks caused by wheel failures more and more imminent; yet to-day the railroads are buying and putting under freight cars chilled wheels which are not strong enough to stand the service. Wheel makers, no matter how inexperienced in the making of good chilled wheels, can secure orders from the railroads by quoting lower prices or giving longer guarantees. A low price paid by one railroad soon becomes the established price for other roads. It is a fact that for several years some of the most important railroads have placed orders for wheels under such conditions of price and guarantee as to make their orders absolutely undesirable to responsible wheel makers, because wheels of good quality cannot be made at the prices paid except at an actual loss. Some railroad officers seem to think that it is the duty of wheel makers to refuse to accept orders under such conditions, but it is not always expedient or possible to do so. No doubt the competition between individual wheel makers has led them in the past and will probably lead them in the future to accept orders on whatever terms are offered and to cut down as much as possible the cost of manufacture and, consequently, the quality of wheel supplied. The railroads, however, eventually get the quality of wheel they pay for.

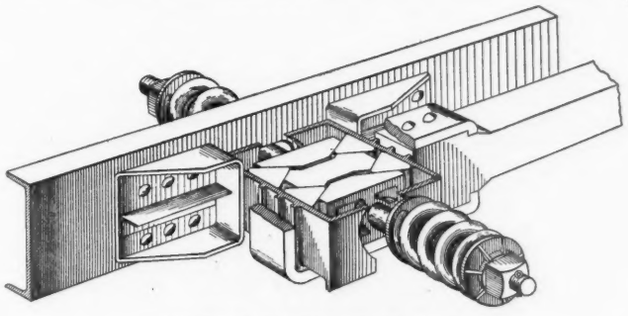
The bargaining for low prices has resulted, in the case of large contracts for some of the important railroads, in placing or withholding orders for wheels on account of a difference in price that would not amount to more than five or ten cents a wheel. This is economy gone mad. Such a small difference in the price would seem to make no particular difference to buyer or seller, or to necessarily involve any falling off in the quality of wheels obtained. But such bargaining has gone on year after year, and the point was reached some time ago where wheels capable of standing up under the increasingly severe conditions of service, on account of greater speed and higher loads, could not be made for the price paid.

One of the unfortunate phases of the situation is that a large part of the wheel renewals under cars are made on foreign cars, and if one or more railroads are buying wheels of inferior quality such wheels are distributed all over the country. A road that insists on buying good wheels and is willing to pay a fair price for

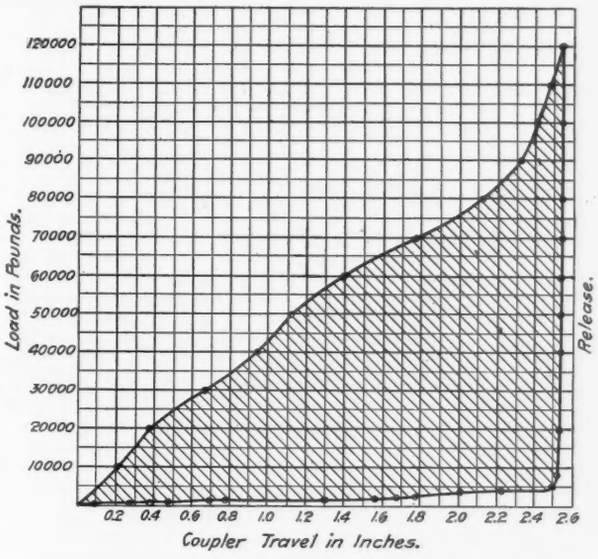
them, may thus be subjected to serious accidents from the failure of inferior wheels under foreign cars, or even under its own cars which have had wheels renewed on some foreign road. Until a price is paid that will enable the use of proper material and conditions of manufacture the railroads collectively and individually must accept the consequences sure to result from the use of cheap wheels. It is the misfortune of the chilled wheel that it is so cheap. Scrap value considered, the cost of eight wheels for one car is less than $40. The addition of $10 to the cost of wheels per car would solve the difficulty. It would seem to be worth this to achieve the desired results in view of the fact that many times this amount is certain to be quickly expended in meeting the cost of failures due to present conditions.

The Cardwell Friction Draft Gear and Rocker Side Bearing.

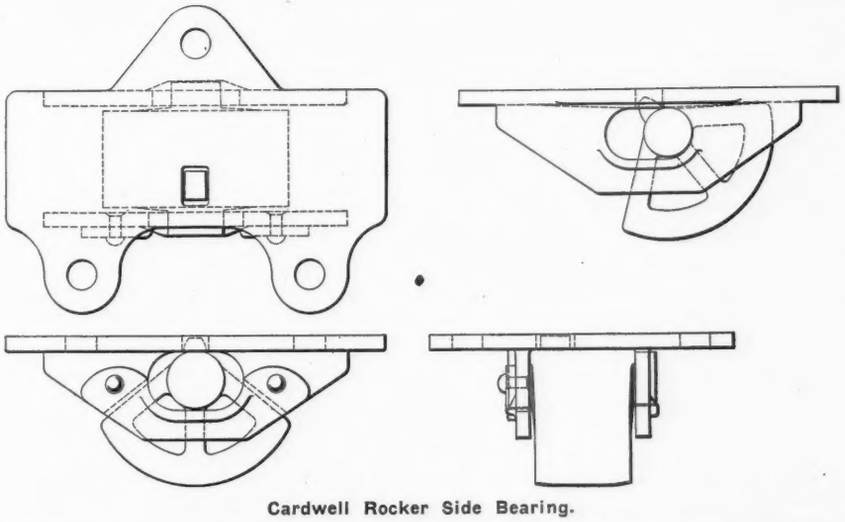
The Cardwell friction draft gear, illustrated herewith, has over 200 sq. in. of friction surface in contact in its normal state. This increases as the gear comes into action to a maximum of 252 sq. in., the increasing surface contact being coincident with increasing pressure from the springs. The peculiar feature of the gear is the location of the springs outside the center sills, with provision for the bodily movement of same with the central portion of the gear, the travel of which approximates one-half the total travel of the coupler.



Cardwell Friction Draft Gear.



Compression Test of Cardwell Friction Draft Gear.



Cardwell Rocker Side Bearing.

The special advantages claimed for this disposition of parts is the availability of the entire space between center sills and within coupler yoke for friction parts; and accessibility of the springs for ready inspection and repair. A broken spring can be replaced without otherwise disturbing the gear, and without having to take the car to the repair track. Ease of adjustability in case of lost motion either from wear of the friction parts or set in the springs is another important advantage, the tightening of the nuts on the spring rod being all that is necessary. The relation and interaction of the friction parts is such that acute wedge angles are maintained throughout the range of action of gear, making it sensitive to the action of the coupler whether the blows be light or heavy.

The friction casings or pocket follower plates surrounding the wedges are malleable iron. The upper portion is cut away in the illustration so that the heavy transverse striking edges of the two, which limit the travel of the gear, are not seen. The springs are M. C. B. standard.

The ultimate capacity of the gear is 160,000 lbs. The accompanying diagram of compression test by R. W. Hunt & Co., Chicago, was made primarily to determine the character of the release curve and was not carried up to the capacity of the gear. This line is practically vertical from the maximum, 120,000 lbs., down to 5,000 lbs. The gear tested had been in active service for eight months on the car from which it was taken. In service tests of the gear, loaded cars have been run together with relative velocities beginning with two miles per hour and increasing to 18 m.p.h. without damage to cars or gear. The most practical test, however, is the results yielded from its use on a thousand cars in service for more than a year without repairs to the gears.

Four classes are made. Class A is for wooden cars. In the aplication to same, ½ in. metallic draft plates, extending from end sill over body bolster and bolted to end and center sills and bolster, are used. Class B is for interchange with twin-spring gears. It is the type shown in the illustration. Class C takes the standard spacing recommended by the M. C. B. Association for friction gears. It has longer pocket follower plates than class B. Class U is a special design for application to Union Tank Line cars, taking a draft lug spacing of 23½ in.

The Cardwell rocker side bearing, one style of which is illustrated herewith, is quite simple, being made in three parts, namely, the rocker and the carrier for same, the latter having a detachable side to permit insertion and removal of rocker. It will be observed that the rocker has a rolling bearing with the carrier plate, giving rolling contact top and bottom and thus minimizing friction. Also the rolling top bearing materially increases the travel of the rocker. In the style illustrated there is a top centering lug and the action is such that when the rocker is released from contact with the truck bearing, its own weight brings it back to the center of the slotted openings in which it rolls. All of the parts are strong and its action is positive. The top portion or carrier is made of malleable iron and the rocker of cast-iron. It weighs about 12 lbs. It is in service on a considerable number of cars and is understood to be giving entire satisfaction.

Both of the devices described in the foregoing are made by the Cardwell Manufacturing Company, Chicago.

The Motive Power Officer.*

BY G. M. BASFORD,
American Locomotive Company.

There is a remarkable fascination about a big, powerful locomotive. When it stands at the head of a train ready to depart or when a magnificent train passes at high speed, or even when the locomotive stands at the gloomy roundhouse waiting its turn for the service necessary to put it in condition for another run, we stop for an interested admiring look.

The locomotive is worthy of the admiration and the respect of all, for it represents a development which has changed the form of human life, and it is one of the greatest influences for good that the

*An address delivered before the Mechanical Engineering Society of Purdue University.

world has ever known. The thought of what the locomotive has done is an inspiring one, and yet there is more to come.

Those who are interested without understanding are fascinated by the power and majesty of the machine. They see only the surface and are mystified, but those who understand the difficulties and appreciate the possibilities are inspired, because they see that the present is but a beginning with a wealth of opportunity for the future.

In the belief that there may be one or more present to-day who will act a leading part in the future, an attempt will be made to indicate some of the principles which may become important.

Our railroads are established and the country depends upon them for its very existence. They were built to meet existing needs and were extended to create new ones, until transportation now becomes our most vital necessity. The struggling enterprises of early days have given place to great and powerful combinations, and the crudities and expedients of the past must give place to the perfection of construction and methods which congestion of traffic necessitates. The traffic of a single district—Pittsburg—to-day would have swamped all the railroads east of the Mississippi river at the time of the Civil War, but congestion is not the only factor to be dealt with. Wages are advancing and rates dwindling as a natural result of irresistible forces.

American railroads are usually built along the lines of least financial resistance and improvement problems in grade reduction and curve specification were handed down to the present generation of managements. Improvements in yards, at terminals and at points in transit simplify the handling of freight, and soon the locomotive will receive its share of development. Heretofore it has grown chiefly in size, weight and power, but there remains another development in the direction of crowding the greatest possible capacity for power within the possible limits of weight and size. Economy of operation, while important, is less important to-day than the provision of the utmost possible capacity of the machine. Perhaps this may be more clearly stated by saying that the greatest need is for that which wil extend to the utmost the capacity of the fireman and render the limited physical strength of a man capable of supplying the requisite power.

This is the locomotive problem for the immediate future—to provide more power without greatly increasing existing weights. A secondary, but scarcely less important field for effort, is the improvement of design and method of operation which will reduce road service failures.

Another opportunity for the greatest abilities lies in revolutionizing methods of motive power management to bring them into parallel with those methods which have brought the greatest successes in the management of vast industrial establishments. Altogether the motive power problem presents possibilities as great as those of any field of mechanical activity and these are worthy of the efforts of the best of men.

Thirty years ago the head of the mechanical department led a comfortable life. He could safely follow precedent and the strenuous life had not been invented. Labor wars had not begun and the stirring emergencies of the present were unknown. It was easy to select shop machinery. There was no shop problem, no pooling of locomotives, no piece work price, no heavy locomotive or large capacity car and no train four-fifths of a mile long. No one cared much about the records of performance or cost of work. Workmen were better trained and good apprentice systems were in force. There was no tendency to go outside of a railroad organization to secure any official, and railroad ways and methods were those of smaller days. There were emergencies, of course, but not the emergencies of to-day. Thirty years ago the railroad official was a good man and as efficient for the time as the official of to-day, but he was a very different kind of official. His facilities were crude and his responsibilities not so great. Locomotives did not weigh 50 tons and other factors were in proportion. The superintendent was his own general manager and he knew every man in the train service. The master mechanic knew all his shop men and the engineers and firemen. He knew their history and he knew all about them and their affairs. Each locomotive had a name and an engineer and fireman were assigned to it. They went into the shop with their engine or they were laid off while it was repaired.

We have no desire to return to the old methods, but those methods are now worthy of thought because while all conditions of service have greatly changed, we have not changed enough in our views as to the proper management and organization of the motive power departments. The past has left us a somewhat unfortunate legacy, of which the result only needs attention on this occasion. The result referred to is seen in the tendency for young men to be easily enticed away from railroad service after they have spent years in preparation for it and are fairly on the road to win success. As a legacy of the earlier days of railroads in this country motive power positions are not, as a general rule, made sufficiently attractive. This, however, is to be changed and the power to bring the change lies in the young men who now hold responsible motive power positions and in those who are to hold them in the near future. As motive power problems and possibilities become better appreciated and better understood, the railroads will surround motive power positions with greater attractions which will eventually render it thoroughly worth while for the very best mechanical talent to prepare for work which, because of its attractions, will preserve this talent to the railroads. There are signs on the horizon to-day that this happy state is coming soon.

As to the locomotive problems of the present we have a few like these: Shall the next lot of passenger locomotives be single or double expansion? Shall we experiment to-day with superheating? Shall we order balanced compounds? Shall we not adopt improved valve gear? For the next very heavy freight locomotives shall we order articulated compounds? Shall we brave the criticisms of those who worship simplicity and order really better locomotives, even if a few complications are involved? In the shop problem, shall we or shall we not organize and operate large plants upon the well understood principles which have made large manufacturing enterprises successful? In the next order for 10,000 cars shall we use all wood, all steel or composite constructions?

These are live questions and those who are to decide them need to understand the reasons why they are presented and why they are pressing.

Shall the next lot of passenger locomotives be single or double expansion? Compounds, because of their favorable use of steam by dividing the range of expansion and the range of temperature changed in the cylinders, are more economical in the use of steam than are simple engines. This improves the efficiency of the locomotive as an operating unit, which is more important than economy. There is less cylinder condensation in a compound because the division of the expansion between the two cylinders reduces the range of temperature and therefore reduces the amount of moisture condensed from the incoming steam for the next stroke. A further advantage in the use of compound cylinders which applies to the three and four cylinder types lies in the fact that the steam is divided into smaller installments and not so much steam is required to pass through a given number of steam ports and passages. This renders a three and four cylinder compound "quicker on its feet" than single expansion locomotives of the same capacity, and, as a matter of fact, the highest speeds in regular train service in the world are made with compound locomotives.

It may seem strange, in view of the superior economy of compound locomotives, that they have not been adopted generally in place of single expansion locomotives. Compounds are apparently increasing in favor at the present time, and this is to be explained rather on the ground of the increased capacity which they render available rather than because of their superior economy. It is claimed by those who have used compounds and discarded them that the additional cost of maintenance, because of the somewhat increased complication, more than offsets the advantage gained by saving a little fuel. While this may have been true some years ago, it is not believed to apply to the more recent types of compounds and it may even be claimed at the present time that the feature of economy may be disregarded. This is because of the very much more important attribute of the compound in applying increased capacity. At the present time railroad men are so anxious to secure the utmost possible capacity that they are willing to accept some additional trouble and expense in maintenance in order to secure the additional power which every railroad now requires in order to deal with trains of increasing weights and speeds. Reliability of service in summer and winter is now becoming very important in competitive passenger service. For this reserve capacity is necessary.

When a railroad official faces the increasing weight of trains and increasing severity of schedules, he is ready to grasp at anything which will help him out of the difficulty. Because compounds do increase capacity, young men who are now preparing to enter motive power service will find it advantageous to have well defined opinions as to the possibilities of the compound to meet future requirements which are going to be more difficult than those of the past or present. When the question of locomotive design is raised on a railroad where an additional car must be hauled and the time must be somewhat shortened, the compound locomotive lies ready at hand to meet this need. Those who are most competent to judge, believe that the locomotive of the future is sure to be a compound.

Shall we experiment to-day with superheating? Superheated steam offers a very attractive field in connection with locomotive development. In German practice it has been remarkably successful and the Canadian Pacific Railway has practically duplicated the stisfactory results obtained in Germany. A number of experiments are now being made in this country, promising very satisfactory results. In short, superheating is one of the fundamental questions in locomotive practice which is worthy of most careful attention at this time.

Superheating does not seem to be antagonistic to compounding, but it serves in the same general direction to reduce heat losses in the cylinders. Condensation of steam in locomotive cylinders and

passages robs the locomotive of a great deal of its power and, in cold climates, this becomes a serious matter. It will always be difficult to thoroughly protect the cylinders and steam passages from radiation and therefore other precautions may be necessary to prevent the loss of heat from lessening the power of the locomotive. Superheated steam, coming into the cylinders at high temperature as it does, permits of a larger loss of heat before producing condensation than is possible with saturated steam where the margin for loss without condensation is very small. Superheated steam may lose to the cylinders and passages a much larger proportion of its heat before condensing, and in this lies the chief advantage of its employment. Superheated steam is also quicker than saturated steam in its movements through passages and ports as is proven by the fact that in Germany seven-inch piston valves suffice for ordinary passenger locomotives.

Such a principle as this cannot be applied to a locomotive without incurring some trouble and expense. While the improvement in the efficiency and economy of the locomotive is very readily attained, it is quite possible that it may be attained at too great an expense of restricted mileage and cost of maintenance, and it is always necessary to nurse a new development in order to make it practically successful. The question at the head of this paragraph should be answered in the affirmative because the possibilities of superheated steam at the present time seem to be exceedingly important and it is perfectly safe to spend the time and money necessary for experimenting because of the practical certainty of the results.

Shall we order balanced compounds? The subject of balanced compounds really requires a paper by itself. Locomotives have become too large to permit of continuing indefinitely the mere increase of size and weight. More scientific development is needed. The usual methods of counterbalancing answer very well for comparatively light locomotives, but as locomotives become larger and the parts become heavier the internal stresses upon the engine itself, due to the inertia of the parts, and the effect upon the track of the unbalanced counterweights renders it necessary to devise a better scheme of balancing. In ordinary practice counterweights are added to the driving wheels for the purpose of balancing the reciprocating parts, but the revolving weights themselves need balancing when near the top and bottom of their paths. When in these positions the counterbalance weights tend to change the weight on the driving wheels, due to their centrifugal action, acting vertically upward when the weights are near the top of their path, and acting vertically downward when they are near the bottom. The counterweights, therefore, tend to lift the locomotive in the one case, and tend to increase the weight on the rails in the other case. This causes the so-called "hammer blow" upon the rail, and because this so-called "hammer blow" sometimes amounts to 25 per cent. of the static weight on the rails, it becomes exceedingly important in limiting the weight allowed upon driving wheels. By using four cylinders and balancing reciprocating parts with other reciprocating parts, and revolving weights with revolving weights, a practically constant pressure on the rail is secured which renders it permissible to increase the weight on the driving wheels without increasing the destructiveness upon the track. By this permissible increase of driving wheel load a larger boiler may be carried, which is greatly to be desired in locomotive practice to-day.

On the Pennsylvania testing plant at St. Louis the Cole four-cylinder balanced compound operated for a full hour at a speed of 75 miles per hour, thus indicating a remarkable capacity. Incidentally, economy of fuel and water constitute attributes of this type of locomotives, and in the constructive features it is found to be possible to materially lighten the parts because the work is divided among a larger number of them. The subdivision of the power reduced the fiber stresses on each of these parts and the disturbing influences of very heavy rods and reciprocating parts are avoided. The effect of reciprocating parts upon the structure of the engine as the movements of these parts rapidly change in direction, has probably never had the attention which its importance merits. For high speed passenger service, and also for freight service the four-cylinder balanced locomotive presents advantages which should be tested to the utmost.

Shall we adopt improved valve gear? Many efforts have been made to improve locomotive valve gear. These have been directed toward an improvement in the distribution of steam, and also to improvements in mechanical construction. Entirely aside from possible improvements in the distribution of steam, the valve gear of American locomotives of very large size present an opportunity for structural improvement which, at the present time, is extremely important. The present tendency toward the use of Walschaert valve gear is due chiefly to the desire to improve structurally rather than to improve the use of steam. It is considered advisable to remove the valve gear from a confined space under the locomotive and also, if possible, to lighten the parts and arrange them in direct lines. The Walschaert valve gear does this, and more. It substitutes easily maintained joints and pin connections for the very large and inaccessible eccentrics and it provides an arrangement which is not as liable to derangement as is the Stephenson motion.

For the next heavy freight locomotive shall we order articulated compounds? Heretofore the locomotive has grown generally in size and weight, without radical change in principle to meet conditions of growth which cannot properly be made through the application of the brute strength idea in design. Large freight locomotives of ordinary types now involve single parts so large as to be difficult to handle in the shop. Their very size gives evidence of the stresses to which they are subjected, and it is believed that the time has arrived for dividing the power and work of the freight locomotive into a larger number of parts as is done in the case of the Mallet articulated compound which has now been successfully running for over a year on the Baltimore & Ohio Railroad. This locomotive weighs 477,500 lbs., including tender, and is the heaviest and most powerful ever built. A glance at this enormous machine immediately indicates the absurdity of designing it upon the basis of two cylinders. This locomotive has operated so successfully as to practically establish the principle of the articulated compound for locomotives which are not nearly so heavy. This general subject of the large freight locomotive is one which now needs, and will continue to need the attention of those who are preparing to deal with the problems of the next few years.

These questions are not to-day always placed before motive power men for final decision, but these are some of the real mechanical department questions which motive power men should be permitted to decide, and if they are decided by the right men many factors of railroad operation will be revolutionized. To the future other questions may be left, but the answers must not be long delayed.

It is necessary to decide upon suitable recruiting methods upon improvements in organization and methods of dealing with the rank and file as well as with the officers and subordinates, to produce a stream of developed talent toward the shop, where it is soon to be more greatly needed than ever before.

What is the locomotive of the future to be? It will be a steam locomotive for a time and then electric. In many places traffic is now sufficiently congested to render electric locomotives attractive, but before the steam locomotive becomes a mere curiosity there remains much for it to do, and its development and its improvement are by no means ended. The electric locomotive, however, is an entirely new problem.

As yet, comparatively little has been done in the improvement of the locomotive in this country in the direction of superior economy and efficiency. In Europe the high price of coal has led to care in design and in operation of locomotives which is unknown here. The French are a generation in advance of us in locomotive operation. In France, locomotive engineers use devices such as double valve gears and variable exhaust nozzles, which we do not intrust to our engineers and firemen. In England, the small number of locomotive failures on the road are a revelation to any one who studies them from our standpoint. In England, the locomotive is given a fair chance by receiving fair treatment, yet it probably does not cost more in the end. We certainly have much to learn from across the water, and while what we may learn is not so much in practice as in method, it is none the less important. That which we most need to learn from England is the value of appreciation of the locomotive and locomotive men. This will be learned and well learned—probably in the near future—of this we may feel sure. We may safely count that when those who are now students are ready to be leaders of mechanical departments of our railroads, the position of the department head will have become an enviable one. There is no field of mechanical work so full of opportunity as this and much depends upon those who are now fitting themselves for the leadership of to-morrow. These leaders may now be in the ranks; they may be in the colleges, but wherever they are their preparation must be thorough, for their work is to be great and it will grow to be still greater.

The idea of the importance of the mechanical problem when demonstrated on a large scale is suggested by the fact that January 1, 1906, a combination of 54 railroads controlled by the Vanderbilt interests became known as "The New York Central Lines." All cars, stations, locomotives and all the office stationery used in transacting the business of these 54 roads will bear this name. This enormous combination of responsibilities is not as impressive in any other of its phases as it is in the matter of the motive power responsibilities. The question of design, of construction, of locomotives, of shops and many other questions which are comparatively small on the individual roads of this combination now become great because of the effect of the practice in one portion of the system upon that in another. It is easily understood that such an aggregation of interests renders it necessary to prepare, through careful study, for every change in practice. The design of shops cannot be made without most thorough and careful consideration of practice in other parts of the system, made with the view of adopting the best in every detail, and the same applies with even more force in the case of locomotives. All this points to the necessity

tor very high authority to properly administrate these responsibilities. In this discussion, only the high points are touched upon, many others beng unmentioned because of the lack of time.

There seems to be no need of arguing at this time in favor of placing full and complete authority for such important problems in the hands of an official who stands immediately next to the throne. This, when done, will mean much to American railroads.

During the last ten years, motive power progress has been rapid because of the change in operating methods brought about by the large train unit. This has brought advances in weight and power which are startling, and the roads are not too well equipped with either physical facilities or men. Some radical changes are necessary.

The "roundhouse foreman" as a designation of position has become outgrown, and the men required for the responsibilities of large and busy rounhouses cannot much longer be called foremen. They must be master mechanics, or the equivalent, because these positions have become more vitally important in the conduct of the railroad. The time has come for entirely separating shop and road responsibilities of subordinate officials. The larger shops require shop superintendents, and the conditions requiring master mechanics to properly look after enginemen, firemen, roundhouse forces and the shops as a combination passed away some years ago. Motive power work is divided into three distinct fields. First, the shop problem. Second, the locomotive operation problem, including roundhouse service. Third, mechanical engineering.

To be successful in either of these, wide experience is necessary. It is into the enginering branch that technical school graduates are most likely to drift, the work being agreeable and being very closely allied to the student's work at school.

Without in any way reflecting upon the opportunities offered in the line of mechanical engineering work, it should be said that experience either in the shops or in the roundhouse is important for a young man who is to succeed. It seems desirable to positively recommend young men to delay entering the engineering work until they have had experience in one or both of the other branches. If they are by temperament and ability qualified for either shop or road administration, they will learn this fact most easily and quickly in connection with the actual work, and if they are better fitted for engineering problems, they will be better able to handle them later on because of the road or shop experience. It seems, in general, desirable for most young men to avoid the drafting room immediately on completion of their college work, and it is believed that in this the most railroad officials will agree.

A word seems to be needed as to progress. In studying the careers of successful men, a prominent fact is developed which seems specially applicable to a successful railroad man. Those who have really advanced most rapidly and have risen highest have usually advanced slowly during the first dozen years. It is believed that an attractive future has been pictured for those who prepare and equip themselves in the right way to carry the mechanical railroad burden of the future. It most assuredly will pay to prepare thoroughly and well, for those who do this are sure to be greeted with most brilliant opportunities. In order to prepare thoroughly and well, however, years of experience are required.

The railroads themselves have not done as much as they might to provide the leadership talent which is so well known to be required for the future. It is in fact on many roads left for the young men who now enter the service to correct this, and they can do so by thoroughly preparing for their work.

No future is brighter than that which is offered in this part of the field of transportation, and it is hoped that some may be present who are to win in this great game. Nothing that is easy brings satisfaction in the doing, and if difficulties are a measure of satisfaction, there is an abundance of satisfaction in this work.

For young men to succeed, it is merely necessary to "make good." Every railroad official is looking for young men who may be trusted to do things. The official does not need to be told who can do them. A young man makes his record by his work itself. He should seek opportunities to do things that somebody wants done and in this way will become sufficiently conspicuous to attract attention. Of these opportunities, motive power work is full to overflowing.

I believe in the motive power officer, in his opportunities, his possibilities and his ultimate success in becoming an executive and administrative official instead of remaining as a chief of a department.

"It is the ship with its bunkers full, its engines tested, its captain forewarned, its straight line voyage charted, that breaks the record into port."

"And it is the minute of talk after the hour of thought, the ounce of effort after the ton of preparation, that steers a business project into the harbor of success."

The New Shops of the Canada Car Company, Ltd., at Montreal.

The new plant which the Canada Car Company, Ltd., has lately completed is considered one of the best examples of a plant of this kind on the Continent; it therefore presents some very interesting features of design and construction. The location on the Lachine canal and Government railroad siding, just west of Montreal, affords the very best facilities for receiving the raw material and shipping the finished cars. The product of the company now consists of complete wooden cars, both for passenger and freight service, but provision was made in laying out the shops for the addition of a steel car plant. The present capacity of the shops, working day turn only, is 20 freight cars a day and 10 passenger cars a month. All forgings and castings entering into car construction are made in this plant. It is not the purpose of this article to describe in detail the various shops and their construction but rather to outline briefly the particular features that contribute to making the plant remarkable for its completeness and general economy of operation. The generation, distribution and application of the power in its several forms constitutes the principal item as affecting the cost of operation. This phase of the subject will therefore be presented in some detail.

View of New Works of the Canada Car Co. Ltd., Looking South Toward Lachine Canal.

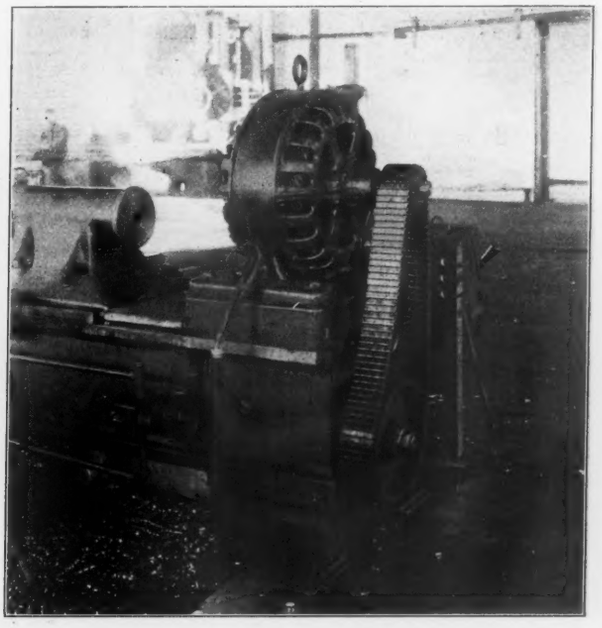
The shops are located on a tract of 50 acres, the buildings occupying a little over seven acres. A record for rapid construction in Canada was established, as less than a year elapsed between the breaking of the ground and the opening of the shops. There are two main groups of buildings. The first contains the planing mill, matching room, cabinet shop, trimming and upholstering shop, passenger and freight erection shop, truck shop and passenger and freight paint shops. The other group embraces the wheel, gray iron and brass foundries, the forge shop, machine shop and pattern shop. The general arrangement of the various departments affords a steady progress of the material through the plant with the minimum amount of handling. The storehouse, paint house, dry kiln, dry lumber shed and office building are under separate roofs in the most convenient places, while the power house is as near central as possible when considering the advantage of its being close to the canal. The shop buildings are all one-story, with comparatively low roofs. The roofs are flat with monitor skylights. The walls are all reinforced concrete, 9 in. thick, which embraces the steel structural framework, and expansion joints are located regularly to localize any cracking of the walls. The roofs are drained towards the center and all drain pipes run down inside the buildings in order that the melting snow can be drained off during the coldest weather. On account of the very heavy snows common to this section, the roof construction was made unusually heavy, and the waterproof covering is of special roofing compound,

laid over heavy sheeting. The walls and monitors are well provided with windows, making the natural lighting very good. These shops are among the largest ever built of all-concrete, and against all precedent and advice, most of it was put in between October and May, during the worst of the winter weather. So far, no serious cracks have developed.

The first or largest group of buildings has a floor area of 183,060 sq. ft., while the smaller group has a floor area of 90,596 sq. ft. All the different shops in each group are similar in design and any particular department can be enlarged without any change in design, simply by additional buildings, and at the same time retain the general arrangement for handling the material and finished product. For instance, the wheel foundry can add moulding floors in the adjoining portion of the gray iron foundry, and increased area in the latter can be obtained by extending the building indefinitely. The roofs are high enough to permit the use of overhead traveling cranes, and those shops not at present equipped with crane service can be so provided by merely adding the runway girders. The shops and yards are equipped with complete fire and drainage systems. The various departments in the large group are separated by fireproof partitions which are provided with Kinnear rolling steel doors.

The power station is worthy of a somewhat detailed description, not because of its size, but on account of the complete equipment, showing the attention given to details. The building is reinforced concrete, 150 ft. long by 85 ft. wide, divided longitudinally by a concrete wall into the boiler room and engine room. It is

Automatic Dump Car Charging Cupola.



Chain Drive on Axle Lathe in Truck Shop.

one story high, and the engine room floor is 8 ft. higher than the boiler room floor, the latter being on the ground level. This gives a spacious basement beneath the engine room for auxiliary apparatus. The boiler room equipment consists of 1,800 h.p. of Babcock & Wilcox water-tube boilers, divided into three batteries of 600 h.p. each. The boilers are designed for 200 lbs. steam pressure and 150 deg. superheat, and are arranged with extension furnaces for the complete burning of all shavings from the mill. They are connected by means of an overhead steel breeching with a Custodis brick stack, 10 ft. in diameter by 150 ft. high. In laying out the power house, it was estimated that the shavings would constitute about 80 per cent. of the fuel required, and on this account it was decided not to install a coal or ash handling system at that time, although provisions were made for overhead coal hoppers and for an underground ash conveyor. Since the plant has been in full operation it has been shown that the estimate was very close as the shavings constitute all the fuel required to operate the power plant during the day. At night the shops are shut down and it is necessary to burn coal to furnish a small amount of power for lighting and some small auxiliaries, and in winter for the heating system. At the present time the coal used is unloaded by hand from cars right in front of the boilers, while the ashes are removed by small cars running close to the ash pits.

The engine room equipment is somewhat unusual in that it contains much of the piping and auxiliary apparatus usually placed in the boiler room. The steam header is carried by brackets on the engine room side of the dividing wall, and all valves are operated from the floor. The steam piping throughout is extra heavy, provided with Van Stone improved flanged joints, being designed for 200 lbs. pressure. The power house piping was installed by the M. W. Kellogg Company of New York. The equipment includes two 500-k.w. Curtis steam turbine units, two exciter sets, switchboard, condenser, air and circulating pumps, air compressor, boiler feed pumps, pumps for water supply, fire protection, heating and oiling systems. The turbines, exciters, switchboard, condenser and air compressor are located on the engine room floor, while the various pumps are all assembled in one section of the basement where they are under the care of one man. The engine room floor is of steel and concrete arch construction, and is of skeleton type, thus giving good light and ventilation in the basement. The layout of the entire power house is such that the capacity can be doubled without changing the general design. A 10-ton crane is provided in the engine room for handling all machines and for use when making repairs.

The electrical equipment is 600-volt, three-phase, 60-cycle, alternating current throughout. No direct current is used in the plant except for exciting the generator fields. One turbo-exciter set of 25 k.w. capacity is used for starting up and a motor-generator set of 30 k.w. capacity is used for regular service. Each shop is controlled direct from the switchboard. The electric power cables are carried to the two main building groups through underground tunnels which are 6 ft. wide by 6 in. high. The steam, water and air pipes are also carried through these tunnels, being supported by brackets on the wall. The tunnels are made of two separate thicknesses of concrete, separated by a double lining of waterproof material. They are well drained and a small pump is provided for removing any condensation. Both the tunnels are practically water tight. Where railroad tracks cross the tunnels, the latter are heavily reinforced.

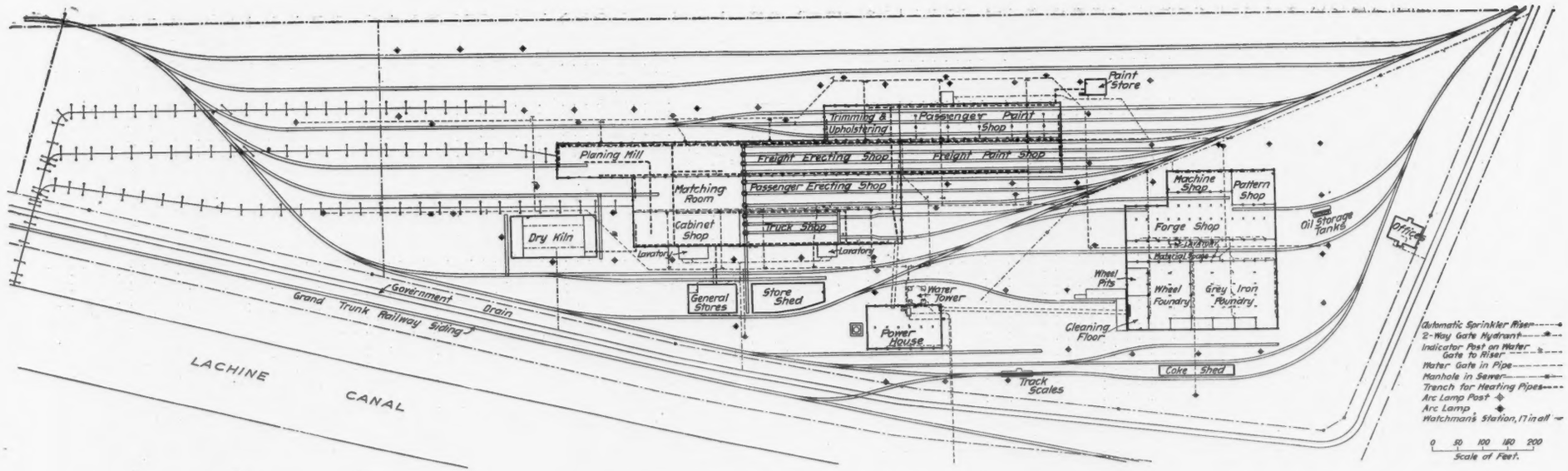
The condensing apparatus was installed by the Alberger Condenser Company, and consists of one counter-current surface condenser, having a surface of 3,600 sq. ft.; one 8 in. x 16 in. x 16 in. x 12 in. horizontal two-stage rotative dry vacuum pump; one 6 in. x 6 in. x 6 in. horizontal duplex water pump; one 30 in. close automatic hot well, and one 8 in. x 16 in. x 18 in. horizontal single piston steam valve independent jet condenser. The condenser system is arranged for independent connection to all the engine room machines, thus permitting any portion to operate condensing while the other is running non-condensing for use with the heating system. The condensed steam is all returned to the boilers.

The air compressor is of 2,100 cu. ft. capacity and designed to run condensing at 200 lbs. steam pressure and 150 deg. superheat. The steam end is an Allis-Chalmers Corliss engine, and the compressor is the Ingersoll-Rand type; both the steam and the air ends are compound. The compressor is said to be the most economical machine of its kind ever built. The air receiver used with the compressed air system is 66 in. in diameter by 18 ft. long, and is located in the basement of the engine room. The compressed air is used for pneumatic hammers, riveters and drills, for a number of air lifts and bending tables, and in the spraying machines used in painting the freight cars.

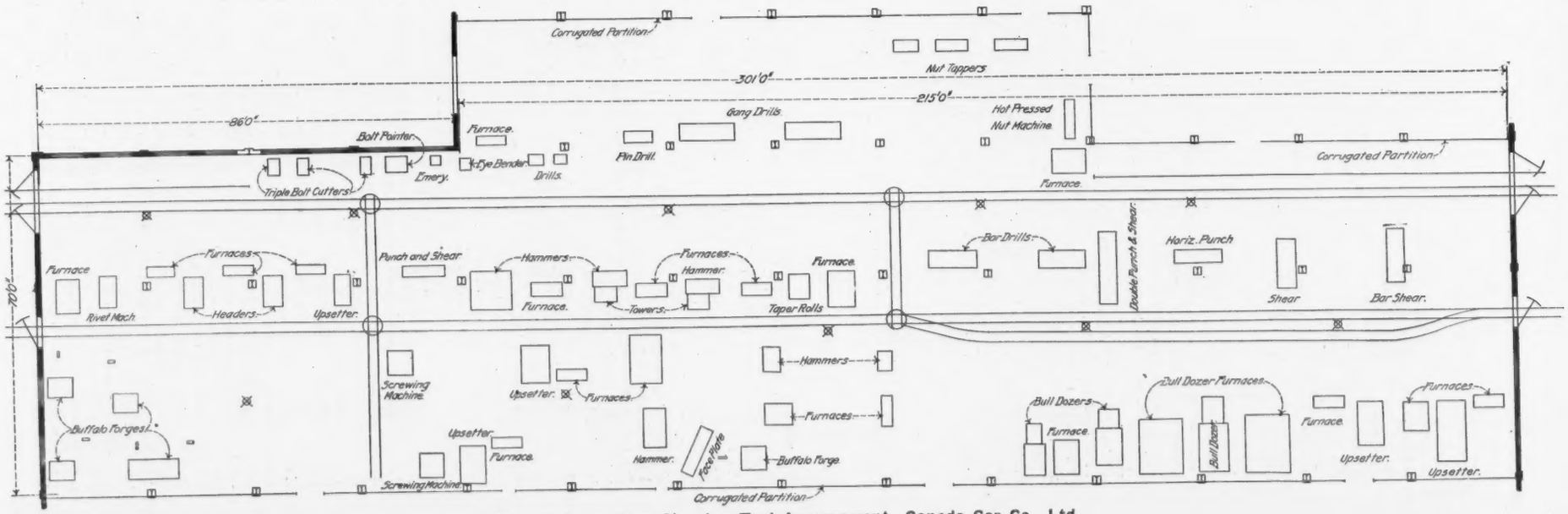
The heating system is another feature worthy of mention. The rigorous climate made it necessary to go into this question thor-

Interior View of Engine Room—Canada Car Co., Ltd.

Interior of Planing Mill—Canada Car Co., Ltd.



Plan of New Shops of the Canada Car Co. Ltd.



Plan of Forge Shop Showing Tool Arrangement—Canada Car Co., Ltd.

oughly and all systems were fully investigated. It was finally decided to heat the shops by the direct radiation method, using the exhaust steam from the power house. The return system is equipped with vacuum pumps which return all condensed steam to the feed-water heater, and which also reduce the back pressure on the turbines to a minimum; 85,072 sq. ft. of radiation surface was installed, and during the past winter the system proved most satisfactory in every way. The shops were always comfortable and the cost of maintenance exceedingly low. The heating system was installed by the W. H. Miller Heating Company, Chicago.

One of the illustrations shows a typical tool arrangement, and the two tables give the sizes of motors and methods of driving used on the wood-working machines in the planing mill, matching room and cabinet shop, and on the machines in the forge shop. In these shops individual motor drives are used almost exclusively and the motors were all selected after very careful and thorough tests of the power required by the various machines. The motors were selected with a view of having them all operate at as near full load as possible when the machines are in normal operation, thus insuring a good power-factor at the switchboard. By the close selection of motors it was shown that the individual motor equipment cost about 90 per cent. of the amount estimated for group drives, and at the same time the capacity of the tools was greatly increased. The shop wiring was installed all overhead in a very substantial manner and all service lines to motors were run in iron conduit pipe.

After the power was carried to the various shops, the motors were divided into 100-h.p. groups, and each group was controlled by an automatic circuit-breaker. This method was employed to prevent any trouble on the lines from shutting down the entire shop at once. These circuit-breakers act very quickly and the breakers on the switchboard controlling the entire shop were provided with time limit relays which would not open the circuit unless the shop breaker refused to act. In this way the shop was protected against a complete shut-down and also the whole circuit was protected at the switchboard in case the protective devices in the shop failed. The circuit-breakers in the shops were designed to prevent their being closed on short circuits. All the motors are General Electric and Westinghouse make, 550-volt, three-phase, 60-cycle. There are four 7½-ton electric traveling cranes: one each in the planing mill and matching room, and two in the forge shop. There is also a two-ton crane in the wheel foundry. All the cranes are equipped with three-phase alternating current motors, specially designed for the crane service. The cranes were built by the Niles-Bement-Pond Company and have proven very satisfactory. The shops are equipped with enclosed alternating current 110-volt arc lamps throughout.

The foundries have several features that are deserving of mention. The wheel foundry has a daily capacity of 300 wheels and has two cupolas each of 21 tons capacity per hour. The gray iron foundry also has two cupolas of nine and 12 tons capacity per hour, respectively. The blast is furnished by two Root positive blowers, direct-driven by two induction motors. The blast piping is so arranged and the gates are so placed that either blower may furnish blast for any one or any combination of cupolas. This gives protection against loss of a heat in either foundry from any possible difficulty with blowers or motors driving them. Two similar pneumatic elevators, each of three-tons capacity, one for each foundry, are used for lifting charges from the ground to the charging floor. The tracks on the charging floor are so arranged that either elevator may be used for raising the charges for both foundries. The charges are loaded on cars, weighed and taken by the elevators to the charging floor. The cars are then run onto a charging machine as needed, and the cars are dumped automatically. The reservoir ladles are tipped by small motors, and are operated, together with the ladle train, from one point by a boy who is able without assistance to distribute hot metal for the entire output of the wheel foundry. The wheel floors are 12 in number, arranged in straight lines. A system of hoists and conveyors runs the length of each floor, extending over the ladle train on one side and over the transfer train for hot wheels on the opposite side. The hoisting and traveling movements are operated by independent mechanisms and controlled by the workmen from any point on the floor. Thus the hot metal is brought from the ladle train and the wheels removed to the transfer train with a great saving in time and labor. The two foundries are considered the most modern in Canada and were equipped throughout by the Whiting Foundry Equipment Company, Chicago.

The larger part of the lumber is received by boat and an overhead telpher system carries the lumber from the canal to all parts of the lumber yard or into the west end of the planing mill. This telpher is also equipped with alternating current induction motors, and is a great factor in the economic operation of the plant. The shavings are removed from the machines in the planing mill and matching room by two fans direct-driven by a 50-h.p. and 75-h.p. motor, respectively. The shavings, as already mentioned, are delivered to the boiler house. In the forge shop, oil is used for fuel in all the furnaces, thus doing away with the handling of coke and ashes. The oil furnaces are of the Ferguson type supplied by the Railway Materials Company, Chicago.

The layout of the entire plant is the result of careful study and design and the uninterrupted manner in which the material passes through the various shops has met with general approval. The results obtained in economy have been entirely satisfactory and in many cases beyond expectations. Mr. W. P. Coleman is President and General Manager of the company, and Mr. C. H. Russell, Secretary. Mr. N. S. Reeder, Jr., formerly Assistant General Manager, but now of the Pressed Steel Car Company, New York, had general charge of the construction of the plant, and Mr. E. G. M. Cape was his assistant. Mr. F. E. McKee, Electrical Engineer, Pressed Steel Car Company, Pittsburg, was Consulting Engineer.

Forge Shop Motor Equipment.

Item No.	Machine.	Make.	Method of driving.	H. P. of motors.
32	Bar shear, No. 11, 10x1½ in., or 1¾ in.	Williams & White	S. G.	15
34	Single punch and shear, No. 11, 2½ in. in 1⅜ in.	Williams & White	S. G.	10
35	Double punch and shear, No. 12, 2 in. in 1¼ in.	Williams & White	S. G.	10
38	Double punch and shear, No.14½, 1 in. in ¾ in.	Williams & White	S. G.	5
39	Horizontal Punch, No. 3, 1¼ in. in 1 in.	Williams & White	S. G.	5
41	Bolt header and forging machine, 1½ in.	Acme Mach'y Co.	B.	5
42	Do., 2½ in.	Acme Mach'y Co.	B.	7½
42A	Do., 3 in.	Acme Mach'y Co.	B.	10
42B	Do., 2½ in.	Acme Mach'y Co.	B.	7½
43	Do., 4 in.	Acme Mach'y Co.	B.	15
44	Do., 1½ in.	Acme Mach'y Co.	B.	5
44A	Do., 1½ in.	Acme Mach'y Co.	B.	5
44B	Do., 1½ in.	Acme Mach'y Co.	B.	5
45	Forging rolls, No. 1	Williams & White	S. G.	15
46	Bulldozer, No. 8.	Williams & White	S. G.	20
47	Bulldozer, No. 4	Williams & White	S. G.	7½
47A	Bulldozer, No. 5	Williams & White	S. G.	7½
30	100-lb. cushion helve hammer	Bradley & Sons	B.	5
31	100-lb. champion power hammer, No. 4	Beaudry & Sons	B.	3
31A	100-lb. champion power hammer, No. 4	Beaudry & Sons	B.	3
16	6-spindle independent gang drill.	Bertram & Sons	B.	7½
16A	6-spindle independent gang drill.	Bertram & Sons	B.	7½
17	6-spindle arch-bar drill	Foote, Burt & Co.	B.	10
17A	6-spindle arch-bar drill	Foote, Burt & Co.	B.	10
18	10-spindle brake-pin drill	Ajax Mfg. Co.	B.	7½
22	2-in. triple-head bolt cutter	Acme Mach'y Co.	B.	5
22A	2-in. triple-head bolt cutter	Acme Mach'y Co.	B.	5
106D	1½ hot pressed nut machine	Ajax Mfg. Co.	B.	5
14	1-in. 6-spdle nut tapping machine	Ajax Mfg. Co.	Group	15
15	2-in. do.,	Ajax Mfg. Co.		
15A	2-in. do.	Ajax Mfg. Co.		
13C	24-in vertical drilling machine	Niles-Bement-Pond	Group	20
13A	32-in. vertical drilling machine	Niles-Bement-Pond		
23	1½-in. triple-head bolt cutter	Acme Mach'y Co.		
23A	1½-in. triple-head bolt cutter	Acme Mach'y Co.		
24	1-in. triple-head bolt cutter	Acme Mach'y Co.		
48	Eye bender, No. 2	Williams & White.		
49	2-in. bolt pointer	Acme Mach'y Co.		
52B	Grading machine No. C, 16x3 in. wheels.	Diamond M'ch'y Co.		

Note.—In column headed "Method of driving," D. C. stands for direct coupled; C. D., chain drive; S. G., spur geared; B., belted.

Planing Mill Motor Equipment.

57	Timber planer, 24x14 in., No. 41.	Berlin Mach. Co.	D. C.	75
57A	Timber planer, 24x14 in., No. 41.	Berlin Mach. Co.	D. C.	75
80	End tenoning machine, No. 4	Greenlee Bros.	B.	15
92	Band rip saw, 14x28 in., No. 109	Fay & Egan	S. G.	30
63	Planer, 15x6 in.	MacGregor & Gourlay	D. C.	40
63A	Planer, 15x16 in.	MacGregor & Gourlay	D. C.	30
75	6-spdle boring mach., 40-ft. table.	Greenlee Bros.	B.	10
75A	6-spdle boring mach., 40-ft. table.	Greenlee Bros.	B.	10
75B	6-spdle boring mach., 40-ft. table.	Greenlee Bros.	B.	10
83	Double end tenoner, 12-in.	Greenlee Bros	B.	30
84	Heavy horizontal mortising machine, No. 6C.	Greenlee Bros.	B.	7½
96	Vert. cut-off saw and grainer, No. 3, 16x10½ in.	Greenlee Bros.	B.	10
99	Automatic cut-off saw, No. 3, 18 x12 in.	Fay & Egan	S. G.	15
98	Brace cutting mach., 24-in. saws.	Greenlee Bros.	B.	10
115	5-spindle vertical boring machine, No. 321	S. A. Woods	B.	7½
79	Heavy gaining machine, 40-ft. table, No. 3.	Greenlee Bros.	B.	10
77	3-spindle vertical boring machine, No. 350	Greenlee Bros.	S. G.	7½
77A	3-spindle vertical boring machine, No. 350	Greenlee Bros.	S. G.	5
74	4-spindle horizontal boring machine, No. 325.	S. A. Woods.	B.	7½
91	Self-feed rip saw, No. 2.	A. W. W. Mchy Co.	B.	10
91A	Self-feed rip saw, No. 2.	A. W. W. Mchy Co.	B.	10
61	Dimension planer, No. 32, 24x24 in. x 18 ft.	Fay & Egan	B.	15
78	Vertical mortising machine, No. 4, 40-ft. table	Fay & Egan	B.	7½
62	Lightning flooring machine, No. 107, 6x15 in.	Fay & Egan	D. C.	30
62A	Lightning flooring machines, No. 107, 6x15 in.	Fay & Egan	D. C.	30
99A	Self-feed cut- off saw, No. 2	Fay & Egan	S. G.	3
99B	Self-feed cut-off saw, No. 2	Fay & Egan	S. G.	3
99C	Self-feed cut-off saw, No. 2	Fay & Egan	S. G.	3
73	Universal boring machine, No. 52	Fay & Egan	B.	5
106A	Self-feed band rip-saw, No. 1, 24x9 in.	Fay & Egan	S. G.	15
106B	Band, rip and resawing machine, No. 146, 24x18 in.	Fay & Egan	S. G.	20
106C	Vertical mortiser and boring machine, No. 302	S. A. Woods	B.	7½
64	Universal wood-worker, No. 4	Fay & Egan	B.	7½
58	Finishing planer,No.153, 36x6 in.	Berlin Machine Co.	B.	10
66	Moulding mach., 12x5-in., No.842	A. W. W. Mach'y Co.	B.	20
103	Sanding machine, 42-in., 3-drum.	Berlin Machine Co.	B.	20
106	Scraping machine, 42-in.	Whitney Mfg. Co.	B.	7½
59	Smoothing planer, Clement, No. 1	A. W. W. Mch'y Co.	B.	7½
	Block and chip grinder.	Mitts & Merrill	B.	50
71	Double-head tenoning machine	M'Gregor & Gourlay	Group	15
81	Tenoning machine, No. 4	Fay & Egan		
94	Swing cut-off saw, 18-in.	M'Gregor & Gourlay		

Item No.	Machine.	Make.	Method of driving.	H. P. of motors.
65	Sash mortiser & relisher, No. 93.	Fay & Egan.....		
65A	Sash mortiser & relisher, No. 604	Greenlee Bros.		
64A	Variety wood-worker, No. 4.....	Fay & Egan		
67	4-side moulding machine, No. 3.	Fay & Egan		
69	Heavy double shaper	Berlin Machine Co..		
84A	Hor. mortising mach., No. 9011.	A. W. W. Mch'y Co		
86A	Band saw, 36-in. wheels, 18-in. under guide.	M'Gregor & Gourlay	Group	20
50	Grindstone, No. 3, 48x6 in.....	Hamilton M. T. Co.		
70	Panel carver and friezer.....	Fay & Egan.....		
85	Scroll saw, 36x39-in. table.....	A. W. W. Mch'y Co		
94A	Swing saw, 18-in.....	M'Gregor & Gourlay		
100	Double rip cross-cut saw, 16-in. saws	M'Gregor & Gourlay		
101	Single end wood lathe, 20-in. swing, No. 3.	M'Gregor & Gourlay		
76	Vertical boring machine, No. 2..	A. W. W. Mch'y Co		
107	Automatic circular saw sharpener	Baldwin-Tuthill & Bolton Co.	Group	5
108	Automatic band saw filer, No. 49B	Do.		
110	Automatic knife grinder, No. 221.	S. A. Woods		

NOTE.—In column headed "Method of driving," D. C. stands for direct coupled; C. D., chain drive; S. G., spur geared; B., belted.

The Art of Water Softening.

BY C. HERSCHEL KOYL.

It should never be forgotten by American railroad men, and it cannot be too often preached to this and succeeding generations, that the vast benefits now accruing and to accrue to American railroad service through the softening and purification of locomotive water, are due principally to the impetus given to investigators by the classic examination of the subject begun in 1871 by a Committee of the American Railway Master Mechanics Association.

This committee collected statistics from all parts of the country concerning the effects on boilers of different kinds of water, and from these statistics they learned the average cost of the additional cleaning, boiler repairs and fuel made necessary by using hard or muddy water. They found that the average cost in railroad work was aproximately $750 per locomotive per year, and that therefore the total cost to the locomotive service of the country was in the millions annually; and they laid down two fundamental rules which are as valuable to-day as they were in the '70s, and doubtless will be standard for all time:

First.—"Get, if you can, clean, soft, natural water."

Second.—"If you cannot get this, then soften and purify the water before it goes to the boiler."

I repeat these maxims in this place because I think they should be committed to memory by every railroad man interested in the locomotive service.

In those days practical water-softening was unknown; but since the time of the first meeting of this committee, and due largely to the continued wisdom of the Master Mechanics' Association, the various chemical difficulties have been overcome, the necessary mechanical appliances for work on a large scale have been perfected, the interest and confidence of railroad officers have been won, and water softening is now a business of established reputation and of great benefit in reducing boiler expense and increasing the continuity of locomotive service.

But just as there were, before the days of real water softening, a hundred quack remedies, all useless and mostly harmful so that James Boon, of the Pittsburg, Fort Wayne & Chicago, had to thunder forth in protest at a meeting of the Master Mechanics' Association, "the only compound fit for a boiler is pure water"—so now there are quacks in the field, men who know nothing of the chemistry or the mechanics of the art, men who by useless and silly operations on water, some of which is better before they touch it than after, are doing much to discredit a valuable business and betray the confidence of the railroad world. It therefore appears to me wise to state a few of the principles of the art, so that those who wish good water-softening service may discriminate between useful and useless processes, and save the railroads money and themselves many heart-burnings.

There are no mysteries in the art of water-softening. The present nearly perfect state of the art has ben attained by years of continued study by scientific men, and to understand it there are necessary only a reasonable knowledge of chemistry and mechanics, and a little common sense.

The whole process consists of two parts only: First, getting the dissolved calcium, magnesium, etc., out of solution and into suspension in the water; and, second, getting this precipitate out of suspension and settled in the bottom of the tank.

Any water can be prepared for boiler use, and water from a softening machine should never contain more than four grains per gallon of the salts of calcium and magnesium. I hear frequently of waters which are said to be so hard that they cannot be softened, but I have yet to find one. I hear of waters which contain so much sulphate of calcium that the softened water will contain too much sulphate of sodium to be usable; but this, too, is stuff and nonsense, for if the water is free from precipitate it may contain 500 grains per gallon of sodium sulphate, without a sign of foaming in a clean boiler.

Softened water should be perfectly clear, that is, it should be free from mud and from the precipitated calcium carbonate, for if there are present either fine particles of mud or fine particles of unsettled precipitate, the boiler will surely foam.

The finished water should contain about one-half grain per gallon of sodium carbonate. Good softened water contains between two and three grains per gallon of calcium carbonate which will be precipitated in the boiler, and therefore the water should contain about one-half grain per gallon of sodium carbonate to keep the calcium carbonate soft, that it may be blown out of the boiler easily and daily.

These are the guarantees which should be required when the contract is made. These are the fruits of the water-softening process, and by their fruits ye shall know them.

Fortunately there are some principles of chemical manipulation and mechanical operation necessary to the successful practice of the art, now so well established that no plant may hope to be in the highest class which has not incorporated them in its practice.

For any ordinary hard water, the reagents to be used are fresh lime for the extraction of the free and loosely combined carbonic acid gas, and sodium carbonate to change the sulphate and chloride of calcium and magnesium into sulphate and chloride of sodium. For clearing the water from matter in suspension, such as mud, it is necessary sometimes to add some two reagents, for instance, caustic soda and sulphate of iron, which will combine to produce a flocculent precipitate—in this case hydrate of iron—which will carry down with it all the suspended matter. These are the only chemical reagents necessary for any ordinary water; and, as they are thoroughly efficient and the cheapest in the market, they cannot be displaced to advantage by other more fanciful substances.

The Lime Treatment.

With water of a given hardness and lime of known purity, it is a simple matter to calculate and supply the exact amount of lime necessary. But commercial limes are of varying degrees of purity, containing from 2 to 40 per cent. of magnesia, and the burning to which the limestone is subjected varies in thoroughness, so that in a ton of purchased lime there may be 2,000 lbs. of pure lime, or there may be 800 lbs. of magnesia and perhaps 100 lbs. of unburned limestone, leaving only 1,100 lbs. of pure lime available for water-softening purposes. It is therefore useless to say "put in 100 lbs. of lime" unless we know its character. Of course the lime must be slaked before use, and this eliminates the unburned stones, but it does not eliminate the magnesia which goes with the slaked lime and is indistinguishable from it. A mixture of slaked lime with enough water to make it flow is called milk-of-lime, whether the lime is pure or whether it is half magnesia; but to this day there are men calling themselves "water-softeners," and accepted as such by some confiding customers, who advocate the use of milk-of-lime by measure for water softening. It is necessary to be very exact in providing just the proper amount of CaO for the extraction of carbonic acid gas from water; but there is only one method by which an absolutely definite amount of CaO can be supplied by weight or measure, and that is by its *solution* in water. A pound of water at a certain temperature will dissolve a certain number of grains of CaO and no more, and it will not dissolve magnesia; from which it follows that if lime is supplied in the form of saturated lime-water, its amount can be definitely calculated and controlled; but to endeavor to calculate the amount of CaO in a pound or a quart of milk-of-lime is pure guesswork, and to endeavor to soften hard water by supplying to it measured quantities of milk-of-lime is also pure guesswork.

A water-softening machine, therefore, to have any rank or standing, must supply its lime in measured amounts of lime water, and in no other way.

The Soda Treatment.

Sodium carbonate, and the other chemicals sometimes necessary, can be supplied only when in solution in water; and if the water-softening apparatus is fitted with the necessary small vats at the top, the supply of these chemicals can be conformed to and regulated by the amount of incoming raw matter if the vats are fitted with valves which themselves are controlled by the incoming stream. But there is a constant tendency to clogging of these small valves by the solid chemicals, due to the continuous evaporation of the water at these points; and for this, as well as for chemical reasons, it is wise to make these solutions as dilute as possible; and any effort to save expense by making these vats small or by feeding concentrated solutions of these chemicals, is misdirected and to the detriment of good operation.

The Mechanical Treatment.

It must be constantly borne in mind that if the water is to be thoroughly softened, every drop of it must get its little proportion of chemical; and since these solutions do not mix readily with hard water, it is absolutely necessary to perform long and continued stirring.

Since the introduction of the "continuous" water-softening machine, no necessary part of the operation has been so constantly overlooked as the very important subject of thorough stirring. All the European machines rely for their mixing on running the com-

bined streams of hard water, sodium carbonate and lime water, around a few baffle plates; but while the mixture thus effected is sufficient to make a decided improvement in the water, still the mixing is not thorough. I have seen many such machines in which the chemical reaction was not complete after two hours' standing, and I have seen water from machines in this country still in process of forming precipitate after the water had been turned into the storage tank. I have found not less than 20 minutes in summer and 30 minutes in winter of determined stirring is necessary to complete the mixing, and therefore the reactions, within the precipitation tank; and if this work is not properly done, precipitation will go on for hours in the settling and storage tanks, with the almost certain result of delivering to the boiler water containing fine particles of precipitate; and the certain result of this is foaming in the boiler.

Summary.

The necessary characteristics of any good water-softening machine are:

First.—That the lime shall be supplied and measured in the form of lime water.

Second.—That the other chemical solutions shall be very dilute.

Third.—That there shall be thorough stirring and mixing of the chemicals with the water, continued for at least a half hour.

The result will be: Water in the storage tank soft and free from particles of precipitate; and properly treated water when used in a boiler will *never scale, corrode nor foam.*

McElroy Automatic Car-Lighting System.

The service conditions on American railroads make the problem of electric train lighting an intricate one. The cars are large, require many lights and a corresponding high capacity of the generator and a wide range of automatic regulation. The service is constant and severe with long runs at steady high speed. Inspection points are far apart. Any system, therefore, which is to be successful under these conditions must be so constructed mechanically and electrically that it will stand severe service without requiring close inspection; must be thoroughly reliable and automatic in its regulation, obviating the necessity of an auxiliary light equipment and must show economy in repairs and in battery maintenance.

The McElroy automatic electric car lighting system shown in the accompanying illustrations is made by the Consolidated Car Heating Co. In the construction and development of this system the aim has been to provide a strong, compact, powerful generator; a thoroughly automatic, reliable and positive means of regulation for current flow to lamps and for battery charging; to reduce to a minimum the cost of inspection, and the necessity for repairs; and to give a convenient, agreeable and efficient light to passengers. The equipment comprises an axle driven dynamo; an automatic regulator for generator output, lamp voltage and battery charging, and a storage battery.

The dynamo is hung between the car axle and the end sill of the truck by the suspension known as the "goose neck cradle type" in accordance with standard practice with street railway motors. The weight is evenly distributed and all shock and vibration on the dynamo is absorbed by the two heavy coil springs which support the shell. The generator is direct driven through a steel cut gear attached to the car axle and a rawhide pinion on the end of the armature shaft. This method of driving is positive and the results obtained have been most satisfactory. All troubles due to breaking, slipping, or adjustment of belts or chains are eliminated. The action of the rawhide pinion and steel cut gear is accompanied by no noise, no lubrication is required and the amount of wear is small. The gear and pinion are enclosed in a pressed steel case to protect them against flying particles from the roadbed and are readily accessible through large inspection doors in the case.

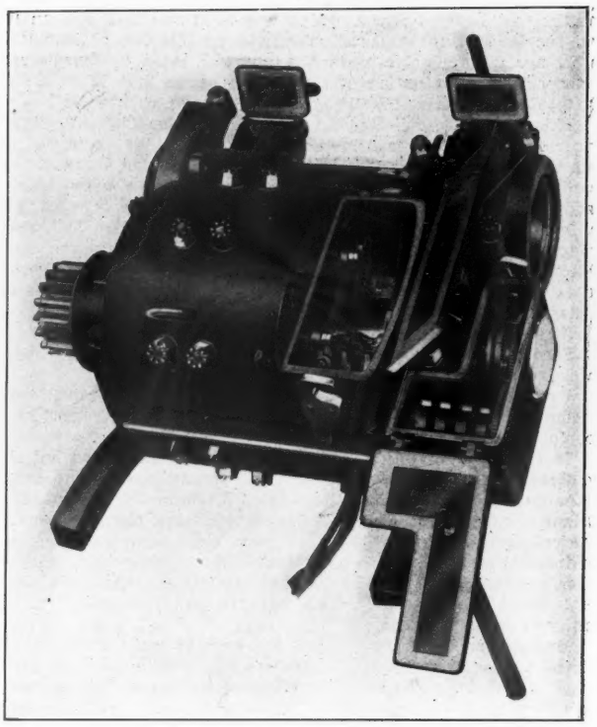
The dynamo is a shunt-wound, four-pole machine and is of sufficient capacity to charge a storage battery of 32 cells with a discharge rating of 40 amperes for six hours and at the same time supply 110, 60-volt, 8 candle power incandescent lights.

Special design is employed for obtaining thorough ventilation for the armature, and perfect commutation at the brushes. The use of band wires for the armature is done away with, thus obviating the danger of stripping the coils. The coils are held in position in the slots by means of fibre strips inserted in triangular notches on the circumference of the discs. Interpolated winding for the fields is made use of in order to obtain sparkless commutation during the variation of field strength necessary in so wide a range of train speed. The construction is simple and does not introduce any complications. Under this arrangement for regulation the brushes will carry a 50 per cent. overload without sparking and with no damaging effect on the machine for two hours. The two brushes are carried on the top of the commutator and are readily accessible for inspection through a large hinged inspection door.

Ball bearings of special foreign design are used on the armature shaft, reducing the frictional load to a minimum. Oiling or inspection of the bearings is only required once in six months.

The reversing switch is carried in a compartment on the commutator end of the shell. It is operated by the armature shaft and reverses the connections of the armature to the mains when the direction of the car is changed, thus keeping the same relations of positive and negative polarity in the external circuit. The construction of the switch is similar to that of a reversing drum switch of a street car controller. Its action is positive and sure when a change is required and after the change is accomplished there is no wear on the end switch mechanism.

The method of regulation will be best understood by referring to the diagram of wiring. The voltage of the dynamo is controlled by a field rheostat operated by a small series, double-field, reverse-wound motor in the regulator case. The rotation of the motor is governed by the combined action of two solenoids which act against the tension of a spring. One solenoid is a shunt wound coil connected across the dynamo mains and the other is a series wound coil in the dynamo battery circuit. When the dynamo is supplying current these two coils act in conjunction. So long as the pull of the solenoids just balances the tension of the spring the arm of the automatic switch is in mid position where the motor circuit is broken and the rheostat arm remains stationary until change in the voltage of the dynamo destroys the equilibrium between the pull of the spring and that of the solenoid when the motor will



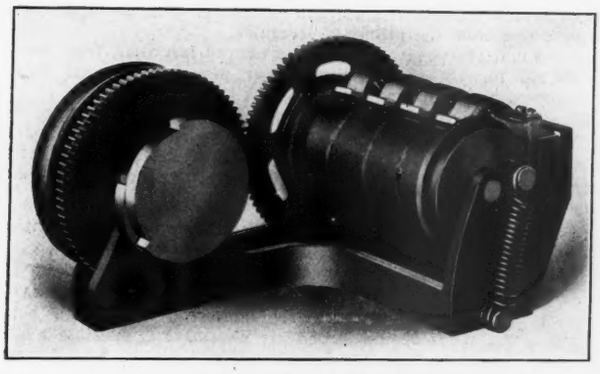
Dynamo for McElroy Automatic Car Lighting System.

again receive current and the rheostat be so adjusted as to bring the voltage of the dynamo to the correct value.

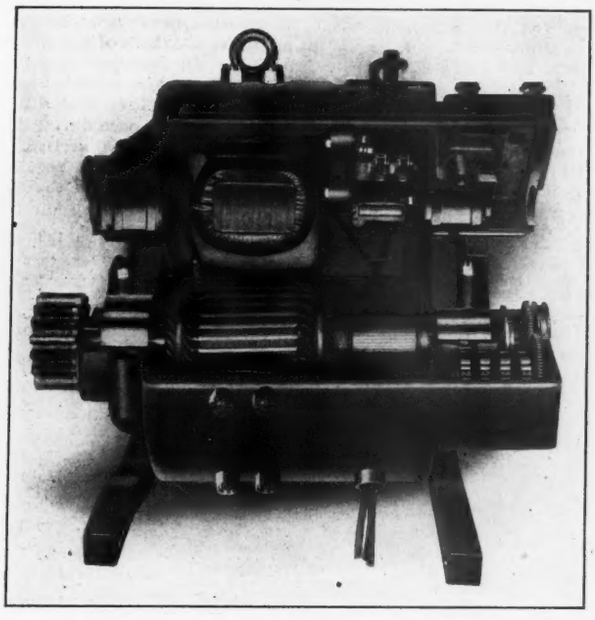
The switch connecting the dynamo and battery is automatically opened when the voltage of the dynamo equals the voltage of the battery. This operation is positive and takes place at zero difference of potential, so that no arcing occurs when the circuit is opened. In reversing the operation when connection is made to the battery, there is also zero difference of potential at the terminals which are connected, and the dynamo picks up the lamp load without fluctuation of the lights.

It will be noted that all current passing to the battery is taken through the heavy series coil of the solenoid, which coil, as above stated, acts in conjunction with the shunt-wound solenoid in controlling the dynamo potential. In case a heavy current passes through the series coil to a depleted battery, the increased pull on the plunger will operate the motor switch and cut resistance into the dynamo field, thereby reducing the voltage and preventing the battery from receiving an excessive charging current. As the charge to the battery nears completion the potential coil assumes nearly the entire control of the solenoid, only a very small current passing through the series coil. The series and potential coils are proportioned so that the proper amount of current is supplied to the battery at all times, this amount varying according to the condition of the battery. This feature is of importance in the effect on both the life and efficiency of the storage battery.

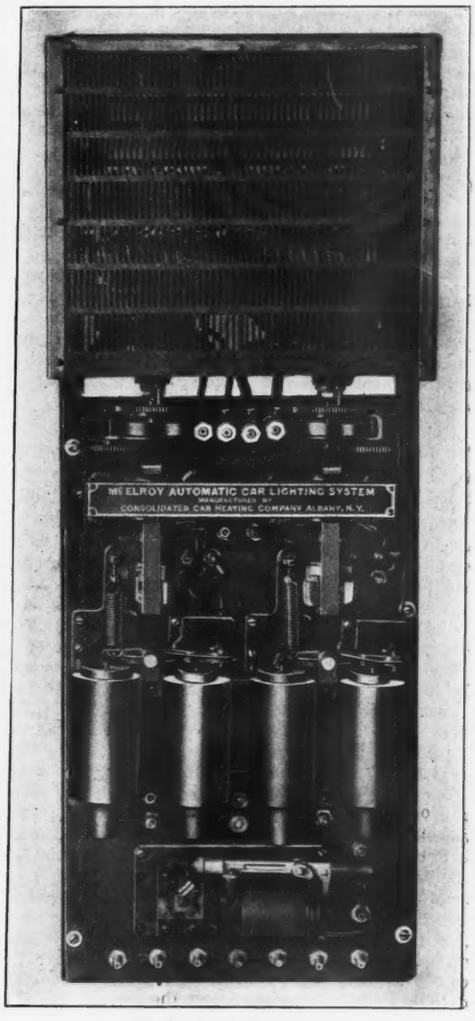
The lamp voltage is controlled through an independent rheostat



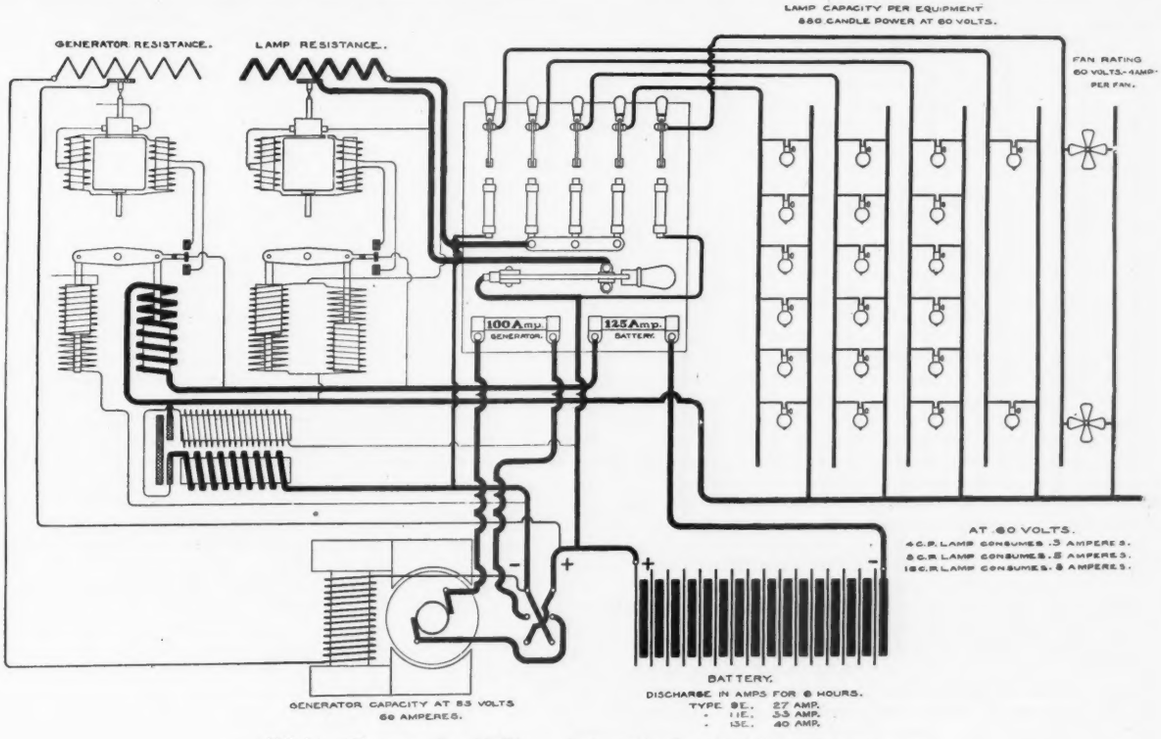
Reversing Switch.



Dynamo and Reversing Switch, Case Open.



Regulator.



Wiring Diagram for McElroy Automatic Car Lighting System.

operated by another motor which is controlled by a solenoid connected across the lamp mains, and is independent of whether the current is supplied from the generator when the car is in motion or from the battery when it is standing still. The lamps can be turned on or off at will, either singly or in groups, without affecting the remaining lights, as the regulator immediately adjusts the resistance to maintain the fixed voltage across the lamp terminals. Regulation of the lamp voltage is constantly maintained within 1 per cent. of the mean value.

A 30-cell battery is used with this equipment, the size varying according to the number of lamps in the car. Owing to the fact that the capacity of the dynamo is such that the battery can be charged at the same time that the lamps are being run direct from the machine, it is not necessary to provide large storage capacity and a battery capable of carrying the lamp load for five or six hours is deemed entirely sufficient for all purposes.

A practical demonstration of the advantages claimed for the above system can be seen at the Atlantic City conventions at the booth of the Consolidated Car Heating Co., where the apparatus is to be in operation.

The Boundless West.*

From 1870 to 1900 the far western states and territories multiplied their population from two to 24 times. In the same period the increase for the United States as a whole was but 50 per cent. The best blood and brawn of the nation and of foreign countries was found in the comers to this new land. The percentage of illiteracy in these far western states and territories is lower than in the older states. With the exception of Utah, Arizona and New Mexico—where nearly every inhabitant is a member of the Mormon or the Roman church—the percentage of church members is considerably lower. Yet who can doubt that upon the lower steppes of the Rocky Mountains—in the Garden of the Gods—where the atmosphere is so clear that Pike's Peak seems but a step from the sugar fields of Greeley and Longmont, or in the Humboldt valley—only 4,000 ft. nearer the sky than we are here—where the blueness of the skies and the brightness of the stars would pale the bluest and brightest of famed Italia—that man loves nature and nature's God and worships him with eye and mind and heart?

The development of the resources of the wonderful Far West cannot be described within the limits of my time. Within the experience of active men adobe villages like Las Vegas, Tucson and Los Angeles; Indian rancheries like Phœnix; mining shacks like Helena, Butte and Boise; a mere prospect upon the banks of a wild and uncontrollable stream, like Spokane—have grown to be cities whose productiveness and attractiveness rival the progress of more than a century in the older states. The prune product of the Pacific Coast states has shut out the importations from Europe, and San Buena Ventura has beans for Boston, and to spare. The raising of Smyrna have been superseded by those of California. The oranges of the Mediterranean now find no market here—we have a surplus for export. Europe flavors its beer with hops from Oregon and Washington. Cattle produced on these far western ranges are marketed—on hoof and in carcass—in London. China and Japan and the South American states take flour in large volume from Washington and Oregon. California's output of gold is greater than ever and Colorado's exceeds it. The products of soil and of mine have been adequate to every enterprise; to all the needs of all industrial pursuits.

Seven distinct lines of railroad now span the continent from the Missouri river to the Pacific ocean. Inclusive of Texas the total length of main line is over 66,000 miles. The wonder they have worked in one generation is but an earnest of what they, unaided, shall accomplish in the generation beginning with the current year. But there are 5,900 miles of additional main line of railroad, the projection of which, within this territory, is not only acknowledged, but much of the work has been contracted and is now largely in course of construction. To these confessed projections it will be safe to add from 1,000 to 1,500 miles which are unavowed. Much of this new construction will develop and serve virgin territory.

Governmental and private irrigation projects within the expectation of men who have crossed the meridian of life will bring under the fructifying influence of never-failing streams approximately 10,000,000 acres of land so fertile as to make the valley of the Nile appear by comparison like the edge of Sahara. These lands are taken up greedily at $25 an acre.

The virgin forests of California, Oregon and Washington, Idaho and Montana are conservatively estimated to contain more than 733,000,000,000 ft. of uncut timber. The human mind cannot apprehend so vast a measure. It would make approximately 75,000,000 carloads of merchantable lumber, each of 10,000 ft.—and such timber! It would be worth a journey to Portland to see the forestry building of the Lewis and Clark Fair, still standing. It is built of fir logs that would make the lumber men of Wisconsin and Louisiana rub their eyes and wonder if they could distinguish a pine tree from the pillars of Hercules.

Eight states in this region produced last year, from beets, over 400,000 tons of sugar. Every year new factories are being constructed and more land is seeded to the sugar beet. . . . There has lately been uncovered in Nevada a deposit of copper ore to reach which over 100 miles of standard gage road is building by the owners of the mine. Indeed, one might discourse all night of the abundant promise of this western half of our part of the continent.

*From an address before the Pittsburg Traffic Club, by J. C. Stubbs, Traffic Director of the Harriman lines.

Program of the Master Car Builders' Convention, Atlantic City, June 13 to 15.

The sessions of the convention will be held in the sun parlor, near the ocean end of the pier. There will be no hotel headquarters. The office of the President, Executive Committee and Secretary will be in the sun parlor. The Secretary will also have a desk in the office of the Enrollment Committee in the entrance to the pier. Immediately upon arrival, each member of the Association should report to the Secretary, register and receive his membership button, if he has none, and be furnished a properly numbered celluloid disc showing his registration. The members of the Association will also be furnished with badges for the members of their families. Cards for registration will be furnished at the Secretary's desk in the entrance to the pier. Those members who will attend only the M. C. B. convention need register but once during the convention, and it should be done immediately upon arrival. Those who stay for the Master Mechanics' convention are requested to register for that convention, after the adjournment of the M. C. B. convention.

OPENING SESSION, WEDNESDAY, JUNE 13, 10:00 A.M. TO 1:30 P.M.

Prayer	10:00 A.M. to 10:05 A.M.
President's Address	10:05 A.M. to 10:25 A.M.
Intermission (to allow visitors to retire should they wish to do so, although all are requested to remain)	10.25 A.M. to 10:30 A.M.
Reports of Secretary and Treasurer	10:30 A.M. to 10:40 A.M.
Assessment and announcement of annual dues; appointment of Committees on Correspondence, Resolutions, Nominations, Obituaries, etc.	10:40 A.M. to 10:50 A.M.
Election of Auditing Committee	10:50 A.M. to 10:55 A.M.
Unfinished Business	10:55 A.M. to 11:00 A.M.
New Business	11:00 A.M. to 11:15 A.M.
Discussion of Reports on:	
Revision of Standards and Recommended Practice	11:15 A.M. to 11:30 A.M.
Composite Design of Coupler Tests of M. C. B. Couplers	11:30 A.M. to 12:00 M.
Topical Discussions:	
1. Circumferential variation allowable in mating wheels. To be opened by Mr. Geo. L. Fowler	12:00 M. to 12:20 P.M.
2. Piece work on Freight Car Repairs. To be opened by Mr. LeGrand Parish	12:20 P.M. to 12:40 P.M.
3. Should not the practice of hinging the running boards at the ends, to uncover ice hatches on refrigerator cars, be abandoned? To be opened by Mr. J. S. Lentz	12:40 P.M. to 1:00 P.M.
Discussion of Reports on:	
Cast-iron Wheels	1:00 P.M. to 1:15 P.M.
Triple Valve Tests	1:15 P.M. to 1:30 P.M.
Adjournment.	

MIDDLE SESSION, THURSDAY, JUNE 14, 9:00 A.M. TO 1:30 P.M.

Discussion of Reports on:	
Brake-Shoe Tests	9:00 A.M. to 9:30 A.M.
Air-Hose Specifications	9:30 A.M. to 10:15 A.M.
Brake Beam Specifications	10:15 A.M. to 10:45 A.M.
Axle Limits	10:45 A.M. to 11:00 A.M.
Rule of Interchange, including Report of Arbitration Committee, Revision of Passenger Car Rules, Prices for Repairs of Steel Cars	11:00 A.M. to 12:00 M.
Topical Discussions:	
1. Should not the uncoupling chains of passenger equipment be so arranged as to guard against the uncoupling of cars in transit by passengers who may be on the platforms. To be opened by Mr. F. W. Chaffee	12:00 M. to 12:30 P.M.
2. Advisability of splicing center sills on cars of 50,000 lbs. or less capacity, in order to perpetuate the cars for two or three years longer, with the least possible expense. To be opened by Mr. F. H. Stark	12:30 P.M. to 1:00 P.M.
Discussion of Report on:	
Revision of Rules for Loading Long materials	1:00 P.M. to 1:30 P.M.
Adjournment.	

CLOSING SESSION, FRIDAY, JUNE 15, 9:00 A.M. TO 1:30 P.M.

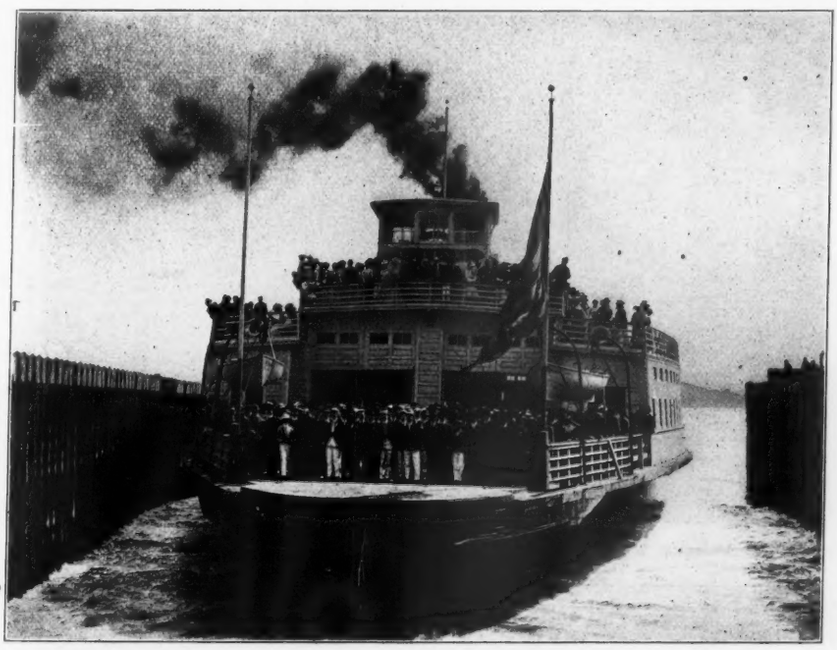
Discussion of Reports on:	
High Speed Brakes	9:00 A.M. to 9:30 A.M.
Height of Brake Staff	9:30 A.M. to 9:45 A.M.
Combination Automatic Couplings for Steam Heat, Air Brake and Air Signals	9:45 A.M. to 10:15 A.M.
Location of Ladders	10:15 A.M. to 10:45 A.M.
Tank cars	10.45 A.M. to 11:15 A.M.
Subjects	11:15 A.M. to 11:30 A.M.
Unfinished Business:	
Reports of Committee on Resolutions, Correspondence, etc.	11:30 A.M. to 12:00 M.
Topical Discussions:	
1. Methods of handling car scrap and usable material. To be opened by Mr. R. F. McKenna	12:00 M. to 12:20 P.M.
2. Desirability of adjusting brake pressure to light and loaded cars. To be opened by Mr. Geo. W. West.	12:20 P.M. to 12:40 P.M.
3. Better fitting up of couplers, even to the point of machining, or at least drilling the pivot pin hole through coupler lugs and knuckle, with knuckle in place and tail of knuckle forced against lock and proper contour preserved under this condition. To be opened by Mr. F. W. Brazier	12:40 P.M. to 1:00 P.M.
Election of Officers	1:00 P.M. to 1:30 P.M.
Adjournment.	

Car Ferry Lines of American Railroads.

BY E. C. DAVISON AND BRADFORD BOARDMAN.

We have collected figures concerning 1,360 miles of car ferry lines operated by 35 companies. The car ferry equipment has nearly trebled since 1897, when the *Railroad Gazette* printed a table giving figures similar to those published in this present one. Nine years ago there were 197 vessels in service, with an aggregate capacity of 2,069 cars. There are now 562 boats, carrying 5,615 cars. The size of the vessels has been much increased, though the average capacity in freight cars remains about 10, freight cars now being about 20 per cent. longer than previously. The average speed of floats towed by steamers is seven miles per hour; steamers carrying cars average about 10 miles per hour. The average number of cars carried daily by all lines is 11,476.

With some small modifications, nearly all companies use the same methods for transferring the cars to the boats and securing them during transit. A counterweighted bridge is hinged at the shore end and usually supported at the outer end on a pontoon. It is raised or lowered to the level of the float by pulleys, hand power being applied directly on a winch or through a hydraulic ram. The Long Island adjusts the height of the bridge by a screw mechanism, operated by an electric motor. The Wiggins Ferry transfers the cars by wooden cradles on iron wheels and steel swing beams. If the route of the boat is in comparatively quiet waters, it is very simple to fasten the cars to the float sufficiently firm so that there is no danger of their breaking loose. There are three common methods, and most companies use at least two of them. They are: setting up the brakes on each car, chocking the wheels, and making the car fast by chains fastened to eyebolts in the deck of the float and passed around either the axle, truck, bolster or the knuckle of the coupler. At the Lehigh Valley terminals, as a rule, only the hand-brakes are set up; if the cars happen to be all connected as they come in from the road, so that the air-brakes may be set, this is done from the switching locomotive after the cars are on the float; that is to say, the air-brakes are only set when it is convenient to do so. It is not considered sufficiently necessary to take any trouble about it. The chocks are sometimes made more effective by using "chock beds," i. e., timbers parallel to the track bolted to the deck on each side of the rails and having squared notches in them to receive the beams of soft wood used as chocks. Instead of ordinary chocks, the Grand Trunk uses rail clamps which stand 12 in. above the rail in front of the wheels, while on the Northern Pacific they fasten eccentric iron blocks to the rails. The Pere Marquette places jacks at an angle under the ends of the body of the car, set so as to take the weight slightly off the bearings.



Steamer Ukiah—California Northwestern.

On the Mississippi and other rivers in the middle west, where boats are often operated in shallow water, side paddle steamers are used to carry cars, or when floats are used they are towed by stern paddle wheel tugs. Such boats can be made with lighter draft than those using screw propellers. They also handle better when there is thin ice on the river.

Companies which operate ferry lines in tidewater harbors use two kinds of car floats. For through car service the floats have three or four tracks, usually three, which take up the entire available deck room, but for pier service, that is, when the cars are run from the railroad terminal to alongside an ocean steamer, a platform is put in the middle between the tracks for convenience in unloading the cars.

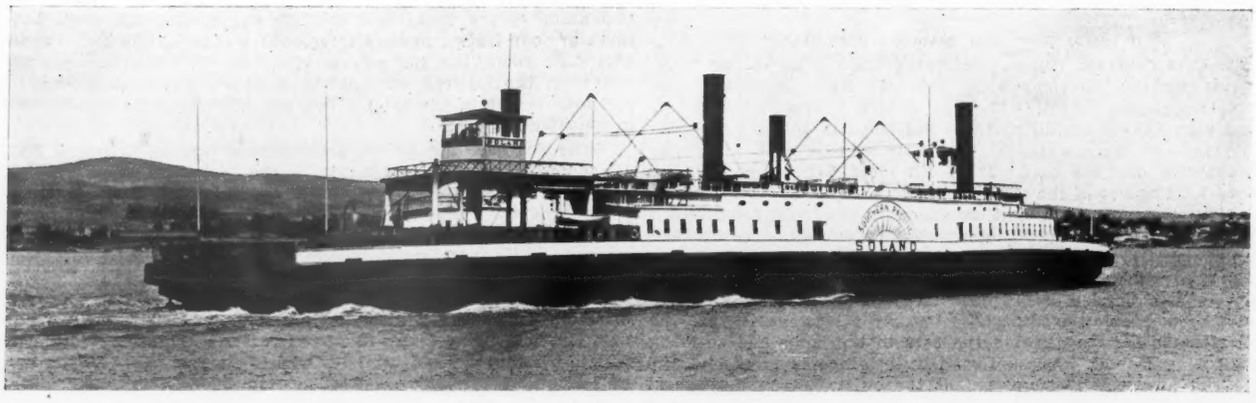
The Southern Pacific has six steamers varying in length from 265 ft. to 420 ft. The best known is the "Solano," which is 420 ft. long over all and 116 ft. 8 in. wide. When loaded she draws 10 ft. 8 in. of water. Her gross tonnage is 3,549 tons, and net 3,057 tons. She was built in 1879 by the Central Pacific and is made of Oregon pine. "The Solano" carries the main line trains between Port Costa and Venicia, Cal., a little less than a mile, and the average time including the transfer of the cars from the land to the steamer, is one hour and fifty minutes for freight trains and thirty-two minutes for passenger trains. She has two beam engines operating the paddle wheels independently, one wheel being set about 20 ft. ahead of the other. The cylinders are 60 in. in diameter, with 11 ft. stroke. The engines are rated at 2,250 horse-power. Oil fuel is used, the "Solano" being the first steamer on the Pacific Coast to do so. This boat has been in service for 25 years, and has been laid up for repairs for only 124 days during that time, 90 days of this having been due to the breaking of a piston rod in 1895.

The Pere Marquette steamers are particularly well known because of the great distance they travel, which necessitates an almost seagoing boat. The company has six steel steamers of 30 cars capacity and three of less, the larger capacity boats being used on Lake Michigan. "Pere Marquette 17," of which we reproduce photographs, is one of the latest of these; she was built in 1901, has twin screws, and is 350 ft. long over all, with 56 ft. beam. She has four tracks on the main deck, and above the spar deck are staterooms for passengers and crews. One of the most important problems these ferries have to contend with is ice. These boats are built with a special view to protection against this, the bow plate being double for 60 ft. and the hulls being built out aft to enclose the propeller shafts. Two triple expansion engines are operated independently. The cylinders are 19 in., 31 in. and 52 in. in diameter, with 36-in. stroke. The maximum indicated horse-power developed is 3,500, giving the vessel a maximum of 15 miles per hour, though the average is 12½. The boats ply between Ludington and Manitowoc, 56 miles, and are in service all the year round.

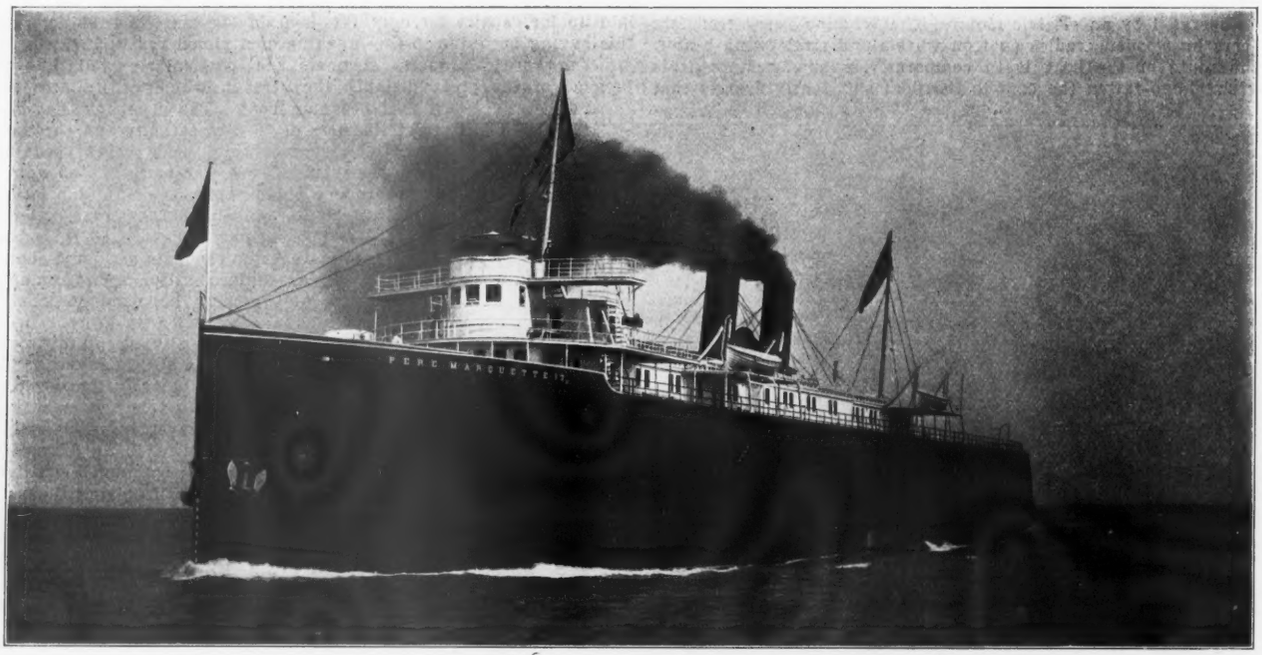
The Michigan Central steamer 'Detroit" illustrated herewith, was built in 1904 for use between Detroit, Mich., and Windsor, Ont., one mile. Her capacity is 21 freight cars; her registered tonnage is 1,307 tons, and gross tonnage 3,089 tons. The hull is of steel and is 308 ft. long, over all, and 77 ft. wide, over all. She draws 10 ft. of water when unloaded. She has four 10-ft. 6-in. propellors, two in front and two behind, driven by four engines developing 3,600 h. p. The high-pressure cylinders are 24 in. by 33 in., and the low-pressure 48 in. by 33 in. The "Transfer," also operated over this route, is unique in having side wheel as well as one propellor.

The California Northwestern steamer "Ukiah" is a wooden side-wheel boat 290 ft. long over all and 41½ ft. broad. Her gross tonnage is 2,564 tons, and net 2,019 tons. Her draft unloaded is 6 ft. The side wheels are driven by one engine, with cylinders 65 in. in diameter and 12 ft. stroke, developing 2,000 h.p. Oil fuel is used. This boat carries 16 freight cars and is fitted for passenger use when not transferring cars. She can make the six-mile trip from Tiburon to San Francisco in less than 40 minutes, with between 2,000 and 3,000 passengers.

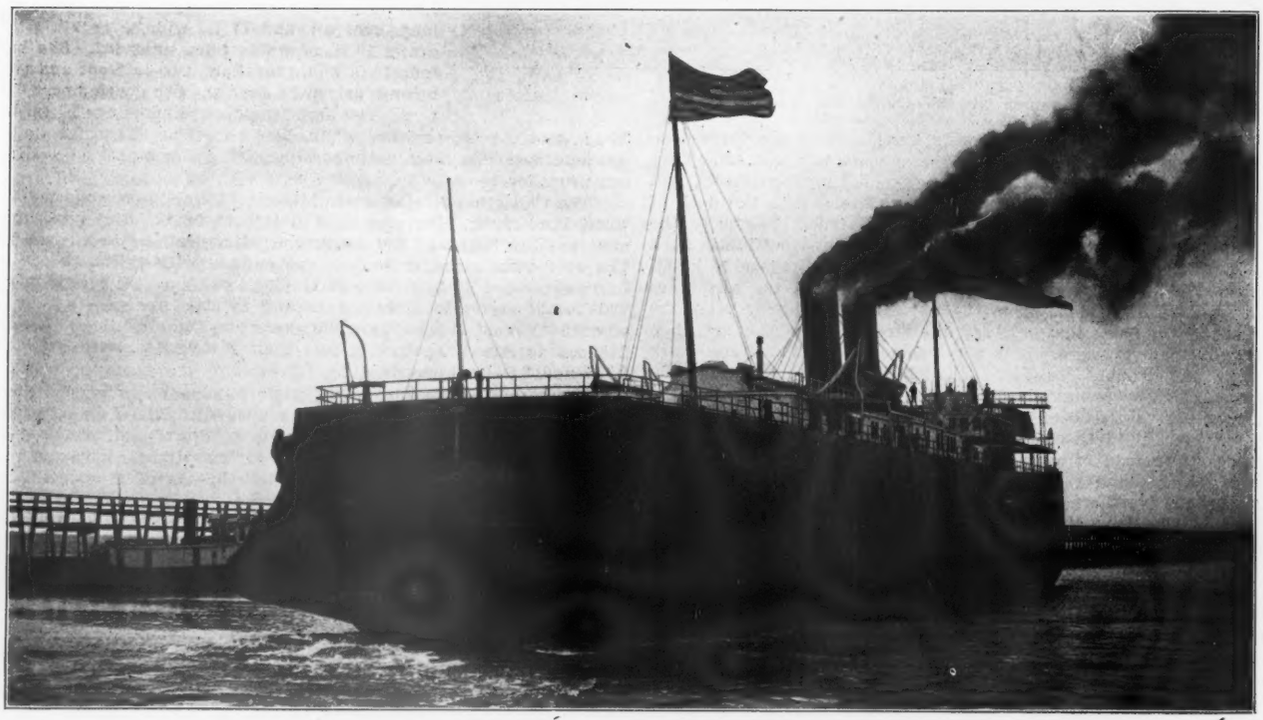
The New York, Philadelphia & Norfolk uses one wooden float and five steel floats; the latter are all built alike, being 340 ft. long and 49 ft. wide over all, with 3½ ft. draft light, and 6½ ft. when loaded. The hull is divided in 17 watertight compartments, each of which is reached from the deck by means of a manhole. There are four tracks on the deck; the two inside tracks carry eight cars each and the outside ones seven each. The rails are carried on steel chairs, one pair being fastened to each deck-beam. These boats were built to cross the rough waters of Chesapeake Bay daily all the year round in any weather, and excellent results have been obtained. On several occasions two compartments have been flooded in collisions, but each time the trip was completed and transferred, the cars unloaded and the barge repaired and put into service again in a short time. Automatic steam towing machines are used and the power for these and for the steam



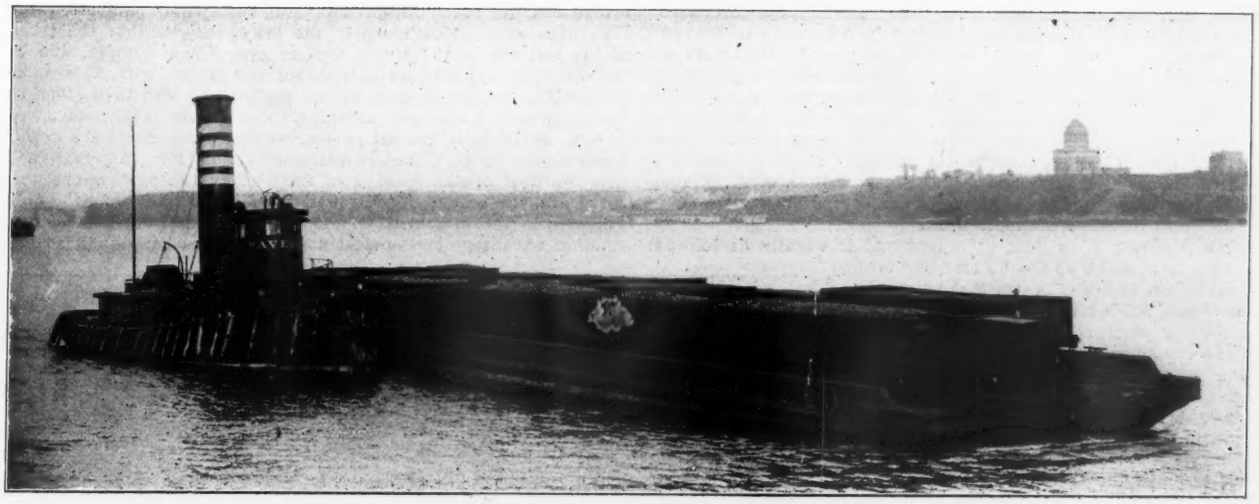
Steamer Solano—Southern Pacific.



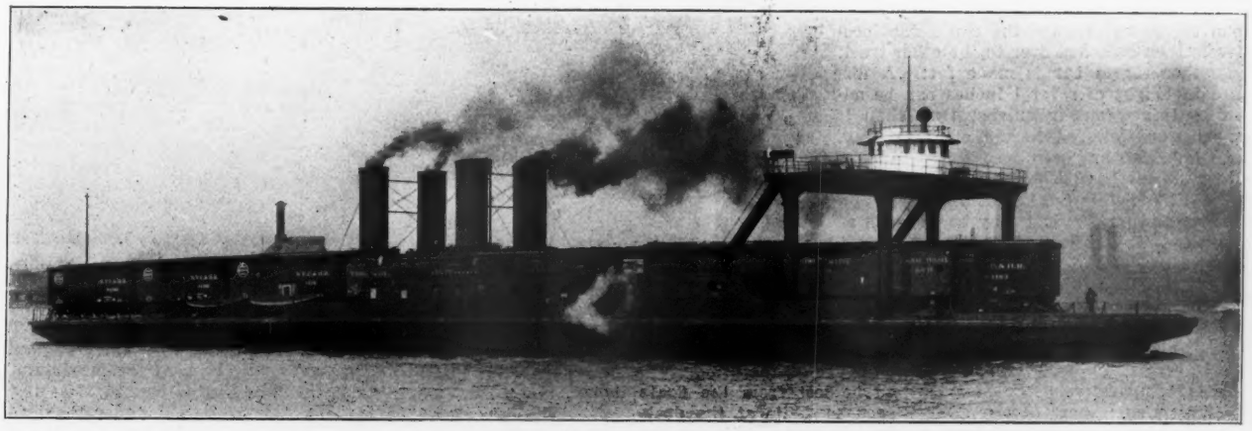
Steamer Pere Marquette 17—Pere Marquette.



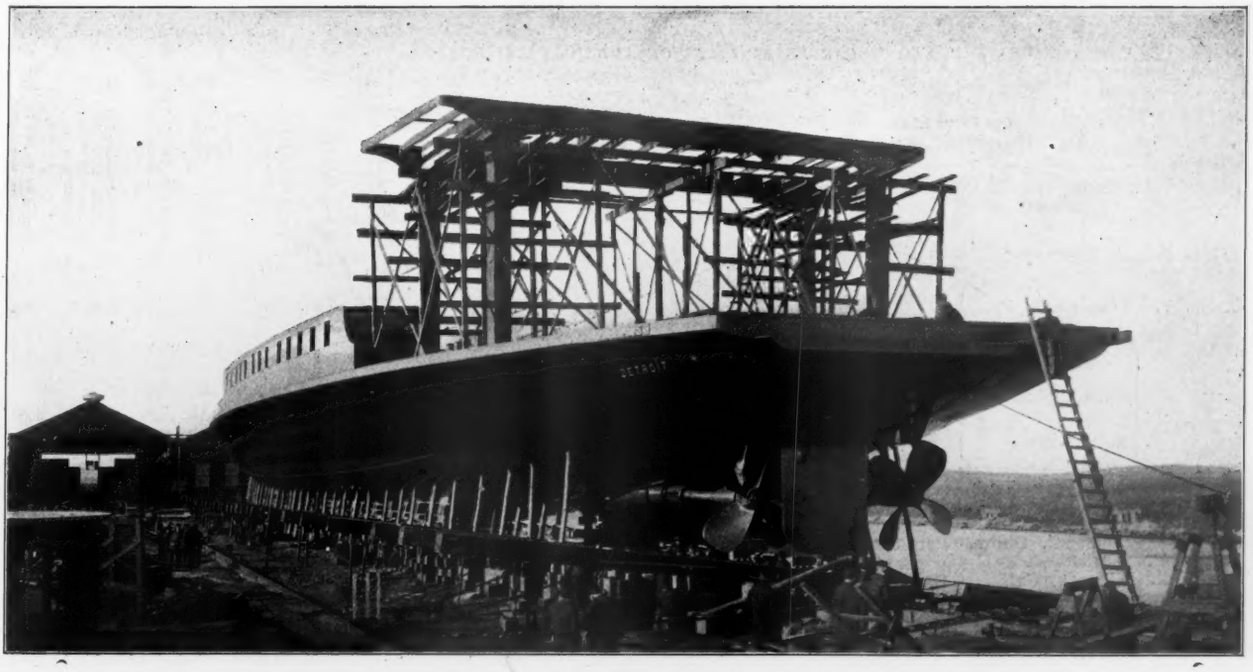
Steamer Pere Marquette 17—Pere Marquette.



Car Float No. 10—Erie.



Steamer Detroit—Michigan Central.

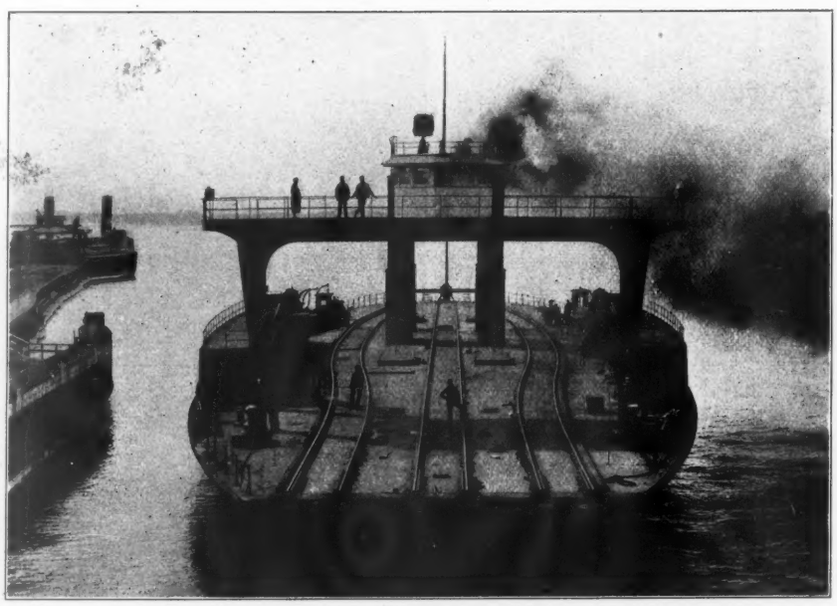


Steamer Detroit, Bow Quarter—Michigan Central.

steering gear, capstan engines, pumps and for heating purposes is furnished from a Scotch marine boiler 5 ft. 6 in. in diameter and 8 ft. long. The towing machine takes up quickly any slack on the tow line and pays it out when a heavier strain is put on it, so that in a heavy sea the pull on the towing bitts is kept constant. The machines are also useful in shortening up the towing line and rapidly taking it inboard when the barge is about to be docked. Since it takes these barges normally about six hours to make each trip, and often longer in rough weather, sleeping quarters for the crew of six are provided amidships on a steel structure about 20 ft. above the main deck.

The handling of a float at a terminal is usually as follows: The float is brought up to the transfer bridge and made fast by ropes drawn taut by winches. There being one of these ropes at each side, this process draws the float up snug and so that the tracks on the float and on the transfer bridge are in approximate horizontal alinement. The final adjustment is made by a ratchet working a screw by which the tracks on the bridge can be slid over a few inches. The bridge is raised or lowered before the float comes in until the tracks are in approximate vertical alinement with the tracks on the float. If, after the float is made fast, the alinement is not accurate enough to slide the toggle bars on the bridge into the toggle caps on the float, time can be saved in adjustment by running the switch engine onto one of the bridge tracks until its weight tilts that side far enough to let one toggle bar engage the cap. The locomotive is then switched over to the other track and another toggle bar is made fast. A difference in height of several inches can be adjusted by this means in quicker time than if the float were lowered in the ordinary way. When the bridge has been used for some time, the toggle bars have a good deal of play, so that the difference in the height of the rails on the bridge and on the float may be as much as two inches. This being too much of a drop for the trucks of the tender to safely take, a flat car is coupled to the locomotive and backed up to the end of the string of cars on the float. Transfer bridges are usually double-tracked. When the float has three or more tracks, the tracks bend together with a crossing frog a few feet from the bow of the boat. The switch points are on the bridge.

It is comparatively rare for cars to be lost from the floats while in transit; most of the accidents occur while at the dock. The engineman of the switching locomotive sometimes fails to obey the trainman's stop signal and backs a string of cars up against the bumper. If the bumper holds, the force is usually enough to break the ropes which make the float fast, in which case the float is driven out from the dock and the cars spilled out between the bridge and the boat. An advantage of having low bumpers, rather than high ones which reach to the drawheads, is that the trucks of the last car of the string will go over a low bumper, and the car will come down on its body on the end of the boat. This makes the trouble evident at once to the engineman, who then stops the train; in such a case the fastening ropes do not break and no car is lost. Steel floats are flat on top, while wooden floats are usually humpbacked to give them greater strength. For this reason, in case the float breaks loose from the dock while the cars are unsecured and the brakes unset, the cars are more liable to slide down grade from the middle of a wooden float than from a steel float. Another advantage of the steel float is that the bow is not so bluff as a wooden boat; it has a long overhang, and when there is ice at the pier it rides over it, instead of packing it up in front. The pontoon is weighted with rocks inside and kept as free from water as possible, so that its lifting power may be near the maximum, it being, of course, easier to let the float down than to raise it up. When the pontoon is damaged a rope is passed under the bridge at high tide and made fast to a gallows overhead; when the tide falls the pontoon drops with it and can be floated out from under the bridge and the necessary repairs made. The bridges have to be made very strong. They are hinged at the shore end so rigidly as to allow no torsion at that point. When heavy cars are run on



Steamer Detroit—Michigan Central.

CAR FERRY LINES OF AMERICAN RAILROADS.

Railroad.	Car Ferry Lines. FROM	TO	Length in miles.	Passenger or Freight Cars.	Equipment: Floats. Number.	Floats. Total capacity, Cars.	Steamers. Number.	Steamers. Total capacity, Cars.	Total vessels.	Total capacity, Cars.	Capacity of largest floats or steamers.	Average daily number of cars ferried.	Average length of time cars are on the floats or steamers.	Average speed in miles per hour.
A., T. & S. F.. Coast Lines	Pt. Richmond, Cal.....	Various points, San Francisco.	7 to 9	F.	4	56	2 tugs.	..	6	56	14	133	1½ hrs.	8
A. C. L.....	Pinner's Pt., Va..	Portsmouth, Va.....	2	F. & P.	4	16	1 tug.	..	5	16	6	8	10 hrs.	4
		Norfolk, Va.....	1½											
Balt. & Ohio.	St. George, S. I..	Various points, New York harbor	3 to 10	F.	43	448	13 tugs.	..	56	448	14	598	3 to 12 hrs.	8 to 10
	Philadelphia ...	Camden, N. J.; various points in Philadelphia harbor ..	1½ to 3½	F.										
	Balt. Harbor ..	Locust Point, Canton and Colgate Creek.	1½ to 3	F.										
	Shepards, D. C..	Alexandria, Va., connecting with So. Railway	1	F.										
‡Bessemer & L. E.	Conneaut, Ohio..	Port Stanley, Ont...	58	F.	..	..	1	30	1	30	30	80	5 hrs.	12
Cal. No.-West.	Tiburon, Cal. ...	San Francisco.....	6	F.	..	..	1	14	1	14	14	..	....	16
Can. Pacific...	Windsor, Ont....	Detroit, Mich.....	1	F. & P.	..	..	2	32	2	32	16	200	30 min.	9
	Proctor, B. C....	Kootenay L'd'g.....	30	F.	6	86	3 tugs.	..	9	86	15	120	3 to 5 hrs.	7
		¶Lardo.....	63	F.	..	..	..	..	..	..	..	..	....	..
	Slocan City, B. C.	Rosebery.	25	F.	2	16	1 tug.	..	3	16	8	32	3½ hrs.	7
	Nakusp, B. C.....	Arrowhead.	36	F.	2	16	1 tug.	..	3	16	8	32	5 hrs.	7

Railroad.	Car Ferry Lines. FROM	TO	Length in miles.	Passenger or Freight Cars.	Equipment. Floats. Number.	Floats. Total capacity, Cars.	Steamers. Number.	Steamers. Total capacity, Cars.	Steamers. Total vessels.	Steamers. Total capacity, Cars.	Capacity of largest floats or steamers.	Average daily number of cars ferried	Average length of time cars are on the floats or steamers.	Average speed in miles per hour.
Cent. of N. J.	Communipaw.	Liberty St., N. Y. ... W. 23d St., New York, and other points in New York harbor .	Average 2 miles.	F.	23	450	7 tugs.	..	30	450	22	..	....	....
Ches. & Ohio.	Newport News...	Norfolk ..... Port Norfolk	12	F. & P.	3	28	1 tug	..	4	28	12	34	2½ hrs.	8
	Norfolk	Port Norfolk.	2½	F. & P.										
C., R. I. & P.	Hopefield, Ark..	Memphis, Tenn.....	1½	F.	..	..	1	10	1	10	10	120	20 min.	10
D., L. & W..	Hoboken, N. J...	Pier 41, N. R., N. Y.	1	F.	21	264	12 tugs.	..	36	264	17	196	12 hrs.	5
		Cortlandt St., N. Y..	1½											
		Brooklyn, N. Y.	5											
		Harlem, New York..	10											
Erie.....	Jersey City. ..... Weehawken.....	Various points, New York harbor.	1 to 15	†F.	24	240	11 tugs.	..	35	240	17	316	6 hrs.	5
Esquimalt & Nanaimo. .	Vancouver, B. C..	Ladysmith.	46	F.	1	12	1 tug.	..	2	12	12	24	6 hrs.	..
Grand Trunk	Windsor, Ont. ...	Detroit, Mich.	½	F. & P.	..	..	3	44	3	44	16	540	30 min.	6
	G'd Haven, Mich.	Milwaukee, Wis. ...	84	F. & P.	..	..	1	28	1	28	..	44	....	14
Ill. Central..	Brookport, Ill....	Paducah, Ky.	3	F. & P.	..	..	2	10 P. or 13 F.	2	10 P. or 13 F.	6 P. or 8 F.	40	20 min. 8 min.	... ...
	Trotter's Pt., Miss.	Helena, Ark.	1											
Lehigh Val..	J. City Terminal	Various points, New York harbor	1 to 3½	F.	20	254	6 tugs...		26	254	22	225	....	6
Long Island..	Long Island City	Pier 32, E. R., N. Y..	4	F.	11	166	5 tugs.	..	16	166	20	250	....	7
		Penn. R.R., Jer. City	7											
		C. R.R. of N. J., J. C.	6½											
		Penn. R.R., Grnvl, N.J.	8½											
Me. Central..	Bath, Me.	Woolwich, Me.	¾	F. & P.	..	..	2	8 P. or 16 F.	2	8 P. or 16 F	6 P. or 12 F.	..	25 min.	...
Mich. Central.	Detroit, Mich. ..	Windsor, Ont.	½	F. & P.	..	..	4	84	4	84	21	1090	....	6
Mo. Pacific ..	Ivory, Mo.	East Ivory, Ill.	¾	F.	1	26	5	31	6	57	26	435	15 min.	5
	Bird's Point, Mo.	Cairo, Ill.	6	F. & P.									45 "	
	Belmont, Mo....	Columbus, Ky.	¾										15 "	
Nash., Chatt. & St. L....	Guntersv'le, Ala..	Hobbs Island	20	F.	3	24	2	..	5	24	10	18	3 hrs.	8⅝
N. Y. Central.	Uptown N. Y. Terminals	Various points, New York harbor	..	F.	41	485	20 tugs.	..	61	485	17	760	10 hrs.	6 to 8
N. Y., N. H. & Hartford..	Harlem R. Term. and Oak Point.	Various R. R. terminals, J. City & N.Y.	6 to 13	F. & P.	46	771	2, & 19 tugs.	16 P. or 31 F.	67	802	22	2000	3 hrs.	8
N. Y., Phil. & Norfolk. ..	Cape Charles, Va.	Port Norfolk	34	F.	6	186	6 tugs.	..	12	186	30	600	....	7½
Norf. & South	Edenton, N. C..	Mackey's Ferry	9	F. & P.	..	..	1	24	1	24	24	81	1½ hrs.	10
		Columbia	29	F.	1	10	1 tug.	..	2	10	10	10	....	5½
North Shore.	Sausalito, Cal. ..	San Francisco.....	6	F.	..	..	1	*17	1	17	17	..	....	7
Nor. Pac.....	Kalama, Wash.	Goble, Ore.	1¼	F. & P.	1	18	1	11 P. or 20 F.	2	11 P. or 38 F.	11 P. or 20 F.	165	20 min.	7
Norf. & West..	Coal Grove, Ohio	Ashland, Ky.	½	F.	1	6	1	..	2	6	6	40	30 min.	5 to 10
Pennsylvania	Jersey City.....	Various points, New York harbor.....	2 to 8	F.	60	700	8 tugs.	..	68	700	20	1000	2 to 24 hrs.	8
	Camden, N. J....	Various points, Philadelphia harbor...	2 to 10	F.	20	180	3 tugs.	..	23	180	10	300		
Pere Marq...	Ludington.	Kewaunee	57	F. & P.	..	..	9	245	9	245	30	450	....	12½
		Manistique	140											
		Manitowoc	56											
		Milwaukee	96											
	Port Huron	Sarnia	1	F.										
	Detroit.	Windsor.	1											
Phil. & Read.	Port Richmond ..	Camden, N. J., and Philadelphia	4	F.	28	224	4 tugs.	..	32	224	8	500	abt 1 hr.	5
Southern Pacific....	Benecia, Cal.	Port Costa.	1	F. & P.	1	6 P. or 12 F.	7 1 tug.	58 P. or 106 F.	9	64 P. or 118 F.	24 P. or 44 F.	..	....	10
	Oakland, Cal.....	San Francisco.....	5¼ to 11											
		Visitation Point. ...												
	San Francisco...	Visitation Point. ...	8											
Tex. & Pac...	New Orleans....	Gouldsboro, La.	1½	F. & P.	..	..	2	28	2	28	16	210	15 min.	10 to 12
Vicks., S. & P.	Vicksburg, Miss.	Delta Point, La.....	1	F. & P.	..	..	1	10 P. or 16 F.	1	16	10 P. or 16 F.	85	12 min.	12 to 15
Wiggins F'ry.	E. St. Louis, Ill..	St. Louis, Mo.....	½ to 1	F.	3	54	2 & 2 tugs.	26	7	80	30	700	1 to 2 hrs.	7
Wis. & Mich.	Peshtigo Harbor, Wis.	South Chicago, Ill..	240	F.	2	52	2	..	4	52	26	40	25 hrs.	16

* Narrow gage. † Occasional special shipments of passenger cars. ‡ Operated by Marquette & Bessemer Dock & Navigation Co. ¶Same equipment available as on Kootenay Landing line; one trip per week.

one of the tracks, their weight warps the bridge, throwing an exceedingly heavy strain on the material of which it is made.

Twelve companies have given us figures showing the average cost of ferrying one car per mile. The average is about 48 cents, the highest being $1.26 and the lowest 13 cents. This large variation is to be expected, as it is reasonable that the company which does the greatest business should do it at the lowest rates; thus the New Haven, which has 67 vessels in service and carries about 2,000 cars per day, has the lowest cost, that is, 13 cents. The Long Island and the Baltimore & Ohio are the next lowest, with 19 cents. By comparing the Delaware, Lackawanna & Western and the Erie, we find that the length of time the cars are on the floats, and the ratio between the average number of cars ferried and the total capacity of the floats seem to be important factors as affecting the cost of operation. The distances traversed by the ferries of these two roads are about the same; they have nearly the same number of vessels, whose total capacity is 240 cars in the case of the Erie and 264 in the case of the Delaware, Lackawanna & Western. But with this equipment the Erie ferries an average of 316 cars a day, while the D., L. & W. only handles 196; also, the cars remain on the floats of the last-named road for about 12 hours as compared with six hours on the Erie, this indicating quicker handling at terminals in the case of the Erie, and consequently the cost per car per mile of the D., L. & W. is 60 cents, and on the Erie 26 cents. There are some companies which, according to the figures we can obtain, are exceptions to these general principles. Both the Northern Pacific and the Norfolk & Western ferry a large number of cars in comparison with their equipment; the cars are on the floats for only a very short time and the floats are moved at the average speed, yet the cost per car mile is $1 on the Northern Pacific and $1.26 on the Norfolk & Western; these figures are over twice as large as those of other companies which, in equipment and amount of business, are comparable to the two roads in question.

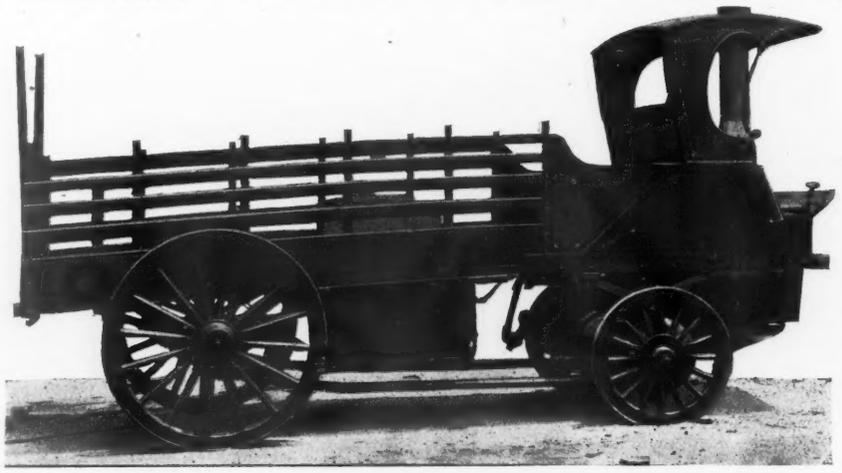
Steel car floats have not been in general use long enough to show actual figures as to their advantages over wooden floats as regards life and cost of maintenance, but all the estimates available make it clear that their use is much more desirable. The first cost is about 25 per cent. greater. This will probably not be true in a few years, as the timber supply is decreasing, especially timbers of such length as are necessary for the construction of car floats. The steel barges are much more convenient to handle, and, in fact, there is about 25 per cent. saving in convenience of operation. The time saved in docking them when there is ice in the slip has already been mentioned. A most important advantage is the strength of their construction. When the floats are loaded, the first string of cars run in on a side track causes the boat to list several feet, and, since the boat is secured rigidly to the bridge by means of toggle bars or similar devices, while the shore end of the bridge is hinged so as to allow only a vertical motion, the listing of the float causes a severe warping strain on both the bridge and the float. Such a wringing tends very soon to open the seams of a wooden float; it has been found that steel floats can be built so strongly that no trouble is experienced on this account. The New York, Philadelphia & Norfolk has had steel barges in use for nine years. They are in good condition and the superintendent estimates a life of 25 years, at least, for them. Their internal parts are more accessible than in the wooden floats.

The accompanying table gives figures concerning nearly every company in the United States and Canada operating car ferry lines. Unless otherwise noted, freight cars rather than passenger cars are understood.

Hermann von Budde, since June 23, 1902, Prussian Minister of Public Works, and as such the head of the Prussian-Hessian State Railroad administration, died of a cancer April 28 last. Von Budde was a soldier until 1900, serving on the general staff, latterly as the chief of the railroad division, which, as all the railroads of the Empire fall under military command in case of war, requires an intimate knowledge of railroad affairs. He retired from the army in 1900 to become the head of a great manufactory of arms and ammunition, but was called to the ministry as above mentioned two years later. He was a man of very great energy and activity, and impressed himself on the affairs of his department to a remarkable degree. The government appreciated him particularly for his success in carrying through Parliament long cherished plans for deep-water canals, which previously had been voted down. Shortly before his death he directed the following to his subordinates: "The dying Minister sends a heartfelt greeting to all railroad men. May the force stand together, a model of faithfulness towards the King and country. This is to be made known to all the railroad men. Minister von Budde."

A New Steam Rail Motor Car.

An interesting design of rail motor car, involving an entirely new application of power, is shown in the accompanying illustrations. The car, which is 52 ft. 9 in. over all, is mounted on two four-wheel trucks of a similar pattern to those used under heavy electric interurban cars. The body is divided into a passenger compartment seating 30, a smoking compartment seating 11, a baggage compartment, and an engineer's cab in the forward end. On each of the trucks are mounted two 50 h. p. (200 h. p. total) eight-cylinder steam motors, entirely encased, and suspended from the axle and the truck frame in a manner similar to the form of suspension used for electric motors on trucks. The shaft of each motor is geared directly to the car axle. Steam is generated in the boiler in the front end of the car, which extends across the entire width of the car just back of the motorman's cab. Eight hundred and fifty gallons of water are carried in the water tank hung under the floor of the car in the center.



8-Ton Steam Motor Truck with Halsey Motors.

This design of car has been evolved from the successful application of similar motors of smaller horse power and a similar steam generating outfit to commercial automobile trucks. Two of these trucks, one of five tons capacity, having two 30 h. p. motors mounted on the front axle and the other of eight tons capacity, having two 50 h. p. motors mounted on the front axle, have been in daily use in Philadelphia for a number of months. The essential feature of the car—the motors—have been successfully employed in stationary work for three or four years and are made in sizes from 2 to 500 horse power. The accompanying sectional drawings show the constructive features of the motors. They are arranged in two pairs of four cylinders each, mounted on a crankshaft within the casing. Two of the pistons have a straight reciprocal motion, the cylinders being fixed in the casing. The other pair of cylinders have a transverse movement on fixed guides and the interior pistons have longitudinal movement within the cylinders at the same time. The admission and exhaust of the steam is controlled by the port openings in the inside casing. There are no movable valves or

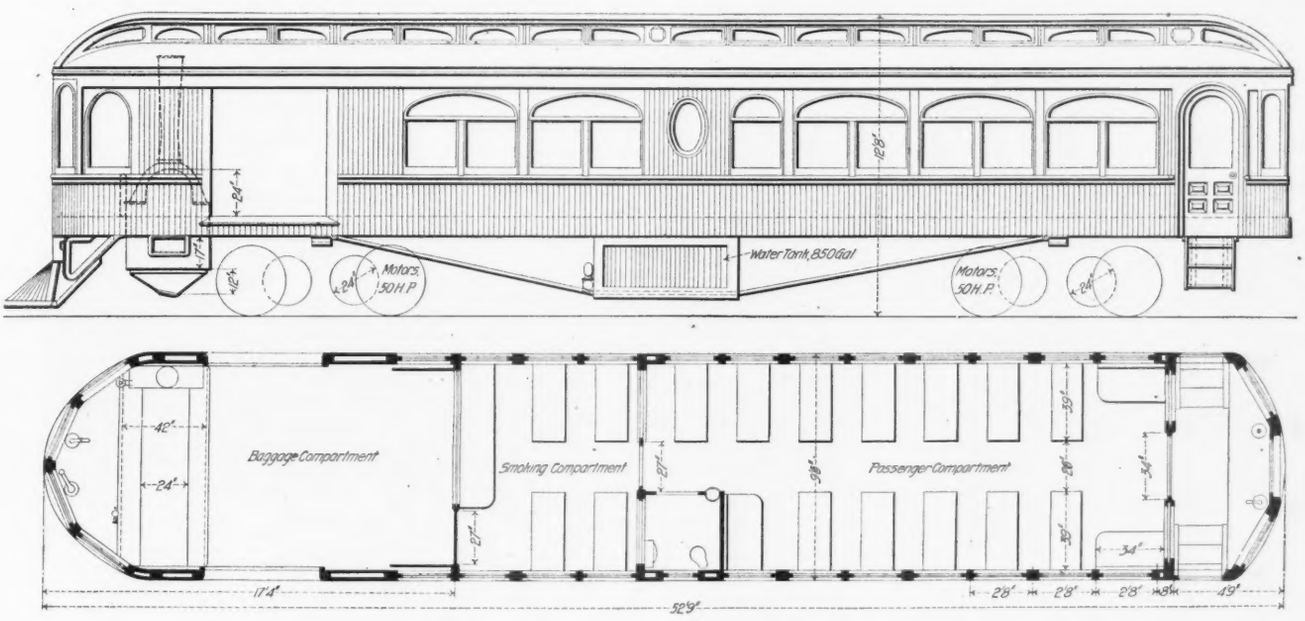
Motor and Casing.

valve gear requiring adjusting or care. The engine is perfectly balanced and is capable of running at 1,000 revolutions per minute at a piston speed of 600 ft. per minute. Variable cut off and reverse are obtained by revolving the crankshaft independently of the inside casing, thereby changing the relative position of the port openings. A quarter of a revolution to the right or left changes the cut off from one-half in forward gear to one-half in reverse gear. For traction work the engines are adjusted for a cut off in forward gear and a small auxiliary steam cylinder is used to revolve the crankshaft into the reverse position. The power control is obtained by the use of the throttle. The principal objection to engines of this class—that is, wear and consequent leakage—seems to have been successfully overcome in this design of engine, as units of this type have been in constant service for more than three years in stationary work without adjustment of any kind, the casing not having been removed during that time. Lubrication is provided for in the ordinary way through a plug hole in the outer casing.

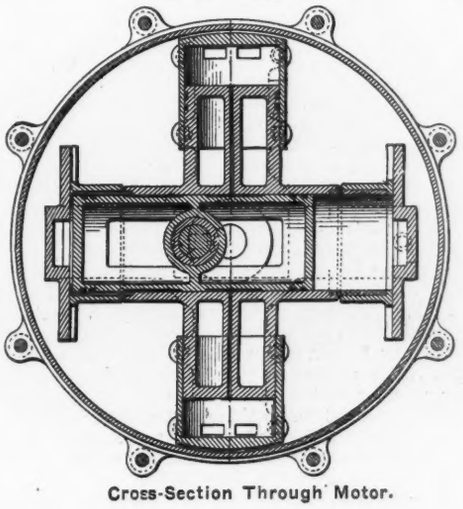
The boiler employed is a water tube marine type of boiler having a large grate area and arranged to highly superheat the steam, which is used at about 200 lbs. pressure. On the trucks now in service the boiler has 12 sq. ft. of grate area, the dimensions of the grate being 3 ft. by 4 ft. On this grate is laid a bed of anthracite pea coal from 6 to 9 in. deep. About 300 lbs. of coal can be fired at one time, sufficient to run the truck for 25 miles or more. By means of a variable exhaust nozzle in the stack the fire can be built up rapidly to supply any amount of steam required. The boiler superheats the steam to between 800 and 1,000 degrees and it is largely due to this superheat that the motors, which are free from stuffing boxes, can be successfully used, as there is little or no condensation when starting out after standing still, and therefore no necessity for draining the water out of the casing in order to have the engine start up quickly. A small reciprocating pump is mounted on the outside of the water tank. This pump takes steam from the main steam pipe back of the throttle valve. When the engine is stopped and the steam pressure begins to rise, the pump begins to work more rapidly and fills the boiler with cold water. At the same time, the exhaust from the stack having been cut off, the fire dies down and the steam does not blow off.

In the application of these motors and boiler to rail motor cars much of the complication involved on a truck is done away with. The 50 h. p. motors are about 24 in. in diameter over all and are geared directly to the axles. Each motor has a live steam and an exhaust steam connection, through universal pipes, with the boiler and stack. The steam reverse cylinder is also connected with the boiler through a small pipe which is first led to the controller. The boiler has a grate area of 24 sq. ft., 3 ft. wide and 8 ft. long. With a bed of coal about one foot thick it will hold 1,000 pounds of anthracite coal, which will supply steam for a run of 100 miles. Before starting out from a terminal the boiler is fired up and then requires no further attention until the end of the run, when the ashes would be shaken down and possibly a small amount of fresh coal fired. The feed pump is mounted on the water tank, as in the trucks, and has a gravity feed, so that it is not likely to get out of order or run dry. Injectors may be mounted on the boiler for emergency purposes. In the cab are mounted the air brake controller, a combined throttle and reverse valve for the motors, and the boiler feed pump valve. These, with the steam and air gages, are all the apparatus requiring attention from the driver. The boiler feed pump once being adjusted to supply the proper amount of water for any given run requires little or no attention, and the regulation of the fire is largely automatic.

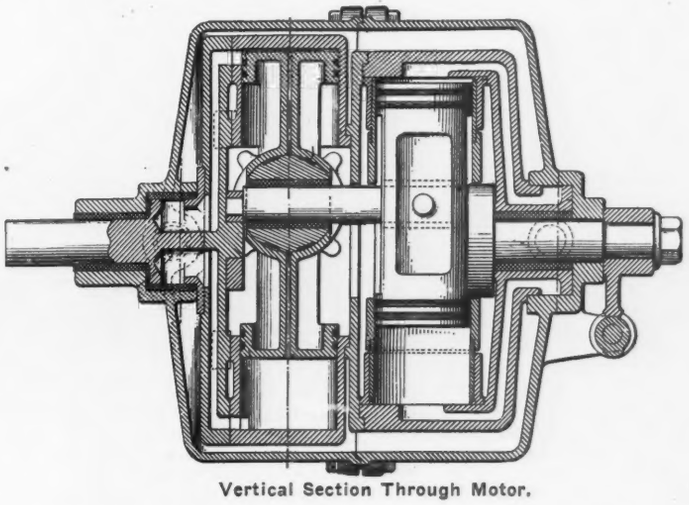
The principal advantages claimed for this design of car are



Plan and Side Elevation of Steam Rail Motor Car.



Cross-Section Through Motor.



Vertical Section Through Motor.

simplicity, low cost of operation, maximum starting and accelerating power, low weight of driving parts, and the small space in the body of the car occupied by the driver and the boiler. None of these cars have as yet been built, but the design appears to be quite feasible. Mr. James T. Halsey, 336 York avenue, Philadelphia, Pa., is the builder of the engines and motor trucks; the application to rail motor car is his also.

Cast Iron Wheels.

Years ago, in the days of light capacity cars, charcoal iron and low mileage, the car builder of a railroad scarcely knew that he had a wheel on his road, in the sense that a healthy man hardly knows that he has a stomach or lungs or a heart, for with the usual accidental exceptions that may come even to a normally healthy man everything went well. The cast-iron wheel was the boast of the American iron master, and was apparently firmly entrenched in use. But with the great increase in car weights and speeds, and the demand for "safety first," the steel-tired wheel gained its foothold and has held it on nearly all roads in passenger service. In freight work the cast wheel was universal, and it was not until the advent of the 50-ton car that the idea crossed the mind of even the most progressive railroad officials that the steel wheel, with its extra cost, would have a chance to compete successfully with the staple article that had done its work so well for so many years.

Attention has been called before in the *Railroad Gazette* to wheel failures that have occurred with cast-iron wheels on high capacity cars, especially on mountain roads, and how officials have been put to it to meet the new conditions. The cast-iron wheel has been greatly improved in strength under the stress of recent requirements by changes made in the shape of the brackets, the form and location of the plate, and by modifications in the mixtures and methods of casting, and there is no doubt that it can be still further improved. There is, however, a growing impression on the part of railroad officials that the 50-ton car is a little too heavy to be carried fully loaded on eight cast-iron wheels. There seems to be little trouble with cars of 40 tons capacity, but the increase of 25 per cent. apparently oversteps the limits of strict safety. It is known what the flange will withstand under a static load, but not as yet anything at all as to what it is called upon to sustain under the varying conditions of service, though an investigation is under way that should throw light on the subject.

In anticipation of these results we can only indulge in a surmise. Laboratory investigations have shown, and attention has already been called to, the fact that the flange of a cast-iron wheel will break under loads of from 40,000 to 116,000 lbs., with an average of about 70,000 lbs. Unfortunately, it so happens that the stronger the wheel the thinner will be the chill and the poorer its wearing qualities, whereas the deeper the chill the less the strength. It appears that this very wide limit in the ability of flanges to sustain a blow is in itself a source of danger, for it is a matter that no direct inspection can detect, and no one would claim that the breaking of any one wheel out of a hundred will give an exact indication of the individual conditions of each of the others. So the strength of the chain must be considered as that of its weakest link, and the resisting power of the flange placed at such a point as judgment and the willingness to take risk may dictate, whether it be at 40,000, 50,000, 60,000 or 70,000 lbs.

Having established this assumed basis of ultimate strength, what shall be the limit of load that is to be permitted? If the investigation referred to shall show that a car of 100,000 lbs. capacity puts a stress of 30,000 or 40,000 lbs. (a guess) on the flange, then it is evident if the factor of safety used in other branches of engineering is a precedent that there is too low a factor of safety on the wheels.

In this case, what is to be done? The cast-iron wheel is accepted as good and standard practice under cars of 100,000 lbs. capacity, yet some roads are putting steel wheels under these cars in order to avoid the dangers of breakages. In doing this on one large road, the question came up as to how the use of cast wheels could be prevented on these cars in repairs, as they would be allowable not only under the rules but by the practice of a road which had a large number in service. The difficulty was solved simply and ingeniously by marking up the capacity to 110,000 lbs. at the time the wheels are applied, and issuing orders that nothing but steel wheels shall be used under cars of that capacity. A 10 per cent. overload will still be allowed with the increased rating, as the bodies and trucks are amply strong enough to carry it. Thus two birds are killed with one stone; the rolling stock is protected from substitution of cast-iron for steel wheels during the transition period, and the operating department is having placed at its service rolling stock that makes a shorter train or an increased net tonnage possible, with a corresponding decrease of ton-mile expenses.

That the steel wheel is abundantly able to sustain the extra load and stresses is certain, for its capacity in this respect is probably more than 600,000 lbs., which leaves a wide margin for sharpening of the flange before the danger limit, that has been crossed by the cast wheel, is even approached. The fact that the steel wheel has gained a foothold in freight service not likely to be released is no reason why the cast-iron wheel should not continue to be improved. In fact, it will probably serve as an incentive to its improvement. In this work it is suggested that possibly the present standard tread is not altogether the best that can be designed for the straight running of the wheel and the prevention of sharp flanges. A straight taper has been used to marked advantage, and the subject, it would seem, is well worth the attention of the committee on standards of the Master Car Builders' Association.

Use of Steel Castings in Car and Truck Building.

BY A. STUCKI.

The steel casting is a metal of comparatively recent date. But the development of its applications has proceeded at such a rapid gait that to-day it holds its own with the other cast metals which had been used for years before the manufacture of cast-steel had even been dreamed of. The improvement in the quality is possibly more wonderful yet, so that steel castings of to-day not seldom take the place of forgings, especially if they are of a rather intricate design.

The reason for such an evolution is not hard to find. In the first place the steel casting in general possesses properties which make it very suitable for conditions existing with rolling stock. Besides that, it is a material which can easily be changed in its composition to suit specific purposes. Owing to the fact that it is as a rule the product of the open hearth furnace, it is possible to try tests before pouring the bath and in this way to verify the proportions of the charge.

If desired, a tough and ductile material can be obtained, which has a tensile strength, elongation and reduction of area similar to rolled steel of low carbon. A well-known railroad official, a year or two ago, discovered what appeared to be a crack in one of his bolsters, ready to go under a car. He at once telephoned for his inspector, and it was decided to scrap the bolster. But before doing so it was decided to put it in the testing machine. Several loads were applied and the bolster straightened out again, after which it sustained a load of at least five times the maximum working load. It was put into service and has stayed there ever since.

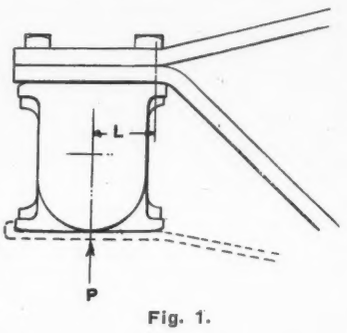


Fig. 1.

The fact that steel castings can be welded should not be underestimated, and even more should it be appreciated that they can be straightened out in case of derailments or wrecks. All these are items which will materially facilitate the repairing of the cars, and will save time and money. After accidents such material has seldom to be scrapped, and comparatively little work will restore these details to their original shape. This is certainly true economy.

To-day steel castings are successfully used in nearly every portion of the car and truck, such as couplers, striking castings, end sills, corner castings, center plates, bolsters, truck transoms, truck pedestals, brake heads and many other details. The substitution of cast-steel for the ordinary arch bars of a freight truck is another important application, and since there are many advantages in this practice a few remarks may be made on this special case.

The present arch bars, it is true, give excellent results throughout the country. None the less, their connection to the spring plank consists in most cases merely of the column bolts. These in turn are exposed to great shearing stresses and the metal in the arch-bars, just around the hole, to great crushing strains every time the bolster presses or hammers against the column. Is it any wonder that these holes wear oblong? But possibly more important is the fact that over 35 per cent. of the arch-bar material is cut away at that point, which naturally leaves the same amount undeveloped in the remainder of the bar. Still the material is there, it had to be paid for, and has to be hauled around the country without bringing in any return of usefulness. With the use of steel castings, the columns and the arch-bars are cast in one piece, so that the column bolt is not needed any longer. This will do away with the large holes in the bars ,while smaller bolt and rivet holes can easily be compensated for without making the remainder of the bars any heavier than necessary. Besides that, the cast arch-bar can be made wider at the center than at the ends, so as to provide for lateral stiffness, where such is mostly needed. This again can be done without the use of additional material.

The stresses existing in the present arch-bars are well under-

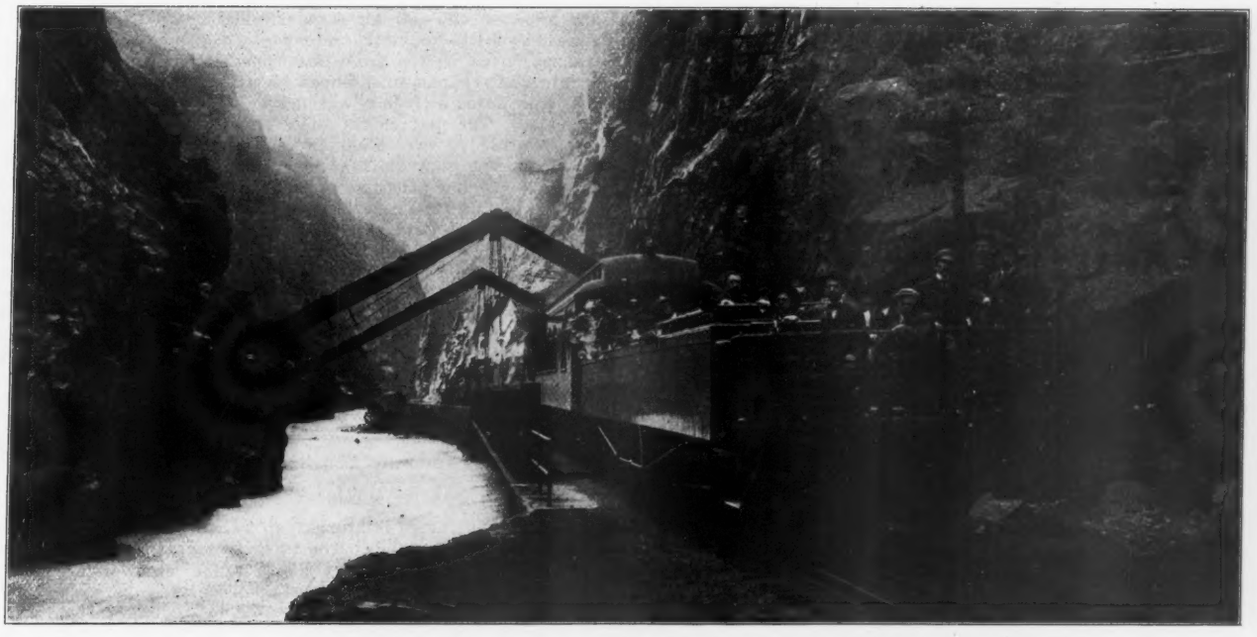
stood, none the less they are somewhat obscure at a point near the end, just where the two bars start to diverge from each other. Considering the bottom tie bar removed, as shown in the sketch, in the case of a 100,000 lbs. truck, bars 5 in. x 1¼ in., loaded car passing a curve at high speed, then the load per journal will be P = 22,850 lbs., distance from center of journal box to neck = L = 6 in., section modulus of two bars $= \frac{2 \times 5 \times 5^2}{6 \times 4^2} = 2.6$, and the fibre stress $= \frac{P \times L}{2.6} = \frac{22{,}850 \times 6}{2.6} = 52{,}730$ lbs., which shows that this portion of the present arch-bars depends entirely upon the bottom tie bar for its strength. This means that the journal box has to act as a diagonal brace and consequently is subjected to great strains whenever the car is loaded. Now supposing that the truck is derailed, and the box gets shocks and blows which could not be foreseen in designing it, is it not natural that the material, strained as it already is, will break? This condition can be very much improved in cast arch-bars, inasmuch as a small amount of metal in the form of ribs will add a great deal to the strength at that point. However, care should be taken that both journal box bolts are of the same length.

Casting the top and bottom bar integral with each other will also obviate the shearing stresses in the journal box bolts, otherwise present at the point where the two bars touch.

Denver & Rio Grande Observation Cars.

The accompanying illustration shows two views of the type of observation car used on the Denver & Rio Grande through the Grand Canyon, the Black Canyon of the Gunnison and the Royal Gorge, during the summer months. The service this year was begun May 15. There is no extra charge for seats on these observation cars. Drawings of these cars were shown in the *Railroad Gazette* June 16, 1905.

Observation Car at Glenwood Springs, in the Canon of the Grand River.



Open Top Observation Car at the Hanging Bridge in the Royal Gorge.

Malleable Cast Iron, Its Manufacture and Its Physical Properties.*

When speaking of malleable cast iron, we understand by that term an iron casting made malleable by a process of annealing. In some branches of engineering we rarely meet with this interesting product of metallurgy, while in other branches—for example, freight-car building, the construction of conveying machinery and agricultural machinery, etc.—malleable cast iron is one of the most important materials the engineer has to deal with, and an intimate knowledge of the physical properties and peculiarities of this metal is therefore highly desirable.

In a modern technical reference book I find this definition on modern malleable cast iron:

"Malleable cast-iron is the name given to castings made of ordinary cast iron which have been subjected to a process of decarbonization, which results in the production of a crude, wrought iron. The castings are made in the usual way, and are then embodied in oxide of iron, etc." Furthermore, it states: "It only requires proper mixtures and proper annealing, coupled with care in other particulars, to make malleable castings that will weld on itself; that will draw out to a knife-edge on an anvil under a hammer; that will temper and cut soft iron like a cold chisel."

This, I think, is too good to be true for ordinary malleable castings, and I have not found any authorities, few as they are, to be as enthusiastic as that. If an engineer with the ability and reputation as that of the author of the definition referred to has such vague ideas about malleable cast iron, it is certainly not to be wondered at that the average engineer has an equally vague knowledge on the subject; and I therefore dare hope that we will all derive some benefit by the following discussion.

Cast iron, as extracted from the ore, is the base for all production of iron and steel with its numerous different properties and uses. We are accustomed to regard all substances accompanying iron as "impurities," but let us remember that chemically pure iron only exists as a curiosity of the laboratory—a substance without any value for structural purposes. Cast iron as a practical metal contains generally carbon, silicon, sulphur phosphorus and manganese, and the various proportions of these ingredients, together with the remarkable phenomena in regard to combined and graphitic carbon, form all the varieties of cast iron, malleable iron, wrought iron, mild steel and tool steel.

There is even more apparent difference between, for example, the gray iron center and the white iron rim in a cast freight-car wheel than there is between the two distinct metals lead and tin, and this great difference is not brought about by any "mixing" in the metal after it left the cupola, but simply by utilizing the well-known phenomena that a sudden cooling of the molten iron will cause a chemical combination between the iron and the carbon it contained previously in the form of graphite. To this phenomena is due the enormous production of chilled cast iron wheels for American freight cars; and it is again this very phenomena which forms the basis for the manufacture of malleable cast iron which, particularly in this country, has reached such enormous proportions and made possible the production of machines and implements at such a low cost as would be impossible without it.

In 1722 Reamur published the fundamental principles for the malleable cast iron process, but it is of comparatively recent years that the industrial world has utilized this knowledge. It was found that if a casting too hard to work were exposed to a continuous high heat for a number of days, imbedding in rolling mill scale (hammer slag) or iron ore, the casting would entirely change its nature, and at the time stated Reamur had collected those observations and found the principles which governed this change in the cast iron. The present generally accepted theory of the malleable cast iron process is to decarburize the metal by some oxide, which will impart a portion of its oxygen to the carbon in the metal at a red heat, forming carbonic oxide, which is given off, thus extracting the carbon. The oxidizing re-agents usually employed are rolling mill scale and red hematite iron ore.

It is important that this material should be as free as possible from sulphur, which is the most objectionable substance in malleable cast iron. The theory as expressed above does not, however, seem to cover the field, as malleable castings are now produced without any decarburizing material, the hard iron castings being packed in fire clay or sand instead of rolling mill scale or hematite ore. For small castings this treatment gives tolerably good results, but for heavier casting tests and analyses show an inferior product. It is already stated that malleable cast iron is produced from hard or white castings, and we will therefore consider the means by which this important property is secured.

The furnace most commonly used in malleable foundries is of the reverberatory type, as this furnace has the great advantage of melting the charge without the fuel coming in contact with the metal. These furnaces vary in details of construction, but the accompanying illustration will give an idea of the general arrangement.

The ash pit is enclosed and contains the air inlet from the blower. The grates are charged (commonly with good bituminous coal) through side doors, which are hermetically closed except at the time of charging. The flame passes the bridge, and in some furnaces there is given an additional supply of fresh air forced through a number of small pipes and in the direction the gases travel. The hearth is slightly inclined towards the bath where the molten metal collects, and on this hearth is carefully piled up the charge to be melted. The roof immediately over the hearth is composed of a number of built-up arches which are handled by a small traveling crane over the furnace. In charging the furnace these arches are removed, and when again placed in position all cracks or joints are closed with fire clay. A little above the high level of the bath are located on each side of the furnace rather small rectangular openings. Through these the events inside the furnace are observed, and through these the wrought iron bars are inserted for skimming off the slag and for "rabbling" or puddling the molten metal until the desired quality is reached. Beyond the bath is the "choke," and finally the smoke stack, about 75 ft. to 100 ft. high. At the bottom of the bath, on each side of the furnace, are located the tapping holes closed by a clay plug as in a cupola. The day's work is started by charging the furnace with pig iron, wrought iron scrap or old steel rails in such proportions as is deemed desirable for the castings to be made from the charge.

The pigs and rails are placed in layers somewhat diagonally so as to permit the flames to circulate freely through the mass on its way over the bath towards the smoke stack. After the charge is placed in the furnace the "bungs" or sectional arches are placed in position, all openings closed and the fire started. Five to 10 tons is usually the charge, according to the size of the furnace.

During the process of melting, which takes three to four hours, the grate surface is kept even to prevent cold air from entering the furnace, and when the charge commences to melt such parts as show a tendency to bake together are separated and led towards the bath where the slag formed is skimmed off so as to present a clean surface of the molten metal to the flame in order to get the full benefit of the heat. After the charge is melted down the bath is vigorously "rabbled' or "boiled" to insure a thorough mixture and to reduce the percentage of silicon to the desired point. This point is determined by dipping out a sample which is rapidly poured into a cast iron mold, quickly cooled and broken. If the fracture indicates the presence of graphitic carbon the "rabbling" is continued until a sample is procured whose fracture shows the desired composition or state of the metal. The molders are now ready with hand ladles to carry off the metal to the flasks nearby, for not only does the metal cool very rapidly but chemical changes take place in the bath and everything has therefore to go with alacrity and dispatch. The tapping goes on from both sides of the furnace at the same time, and within about 30 minutes the whole charge is emptied and the furnace is allowed to cool down to receive a new charge.

The castings are removed from the flasks, the sprews and vents are knocked off, and all cores cleaned out. The metal is now almost as brittle as glass, and some care has to be exercised in its transportation to the annealing house. Here castings of similar weight and sections are grouped together and carefully "packed" in cast iron boxes or frames varying in size to suit the articles to be annealed. The first one of these frames is placed on a cast iron plate resting on two blocks in such a manner that the prongs of the hand charging machine can enter under. The pieces to be annealed are now placed so that they may be completely surrounded by the packing material (rolling mill scale or red hematite ore) and care is taken that some parts of the castings project over the edges of the box, in this way forming a guide for the next section.

A pile of about 5 ft. high is formed in this manner, and, when completed, removed by the charging carriage to the annealing furnace, where the piles are placed in rows so as to allow the flames from the fire grate free play. The opening of the annealing chamber is finally bricked up tight and the fire started. These annealing furnaces are arched chambers about 7 ft. high x 12 ft. deep and 8 ft. wide, with canals in sides and under the floor so arranged as to convey the flames and the hot gases evenly through the rows of piles, and thus produce an even temperature. Natural draft is used, and the firing carefully moderated during the whole period of annealing from two to six days or more, depending on the character of the castings.

The temperature is brought up to a bright cherry red or about 1800 degrees Fahrenheit. The furnace is provided with sight holes for observation and the blue flames at the joints of the boxes give an indication of the process going on inside where the combined carbon leaves its union with the iron to combine instead with the oxygen, in turn loosened from its combination with iron in the ore or scale, and forming a new combination carbonic oxide or dioxide, the gas producing the blue flames before referred to.

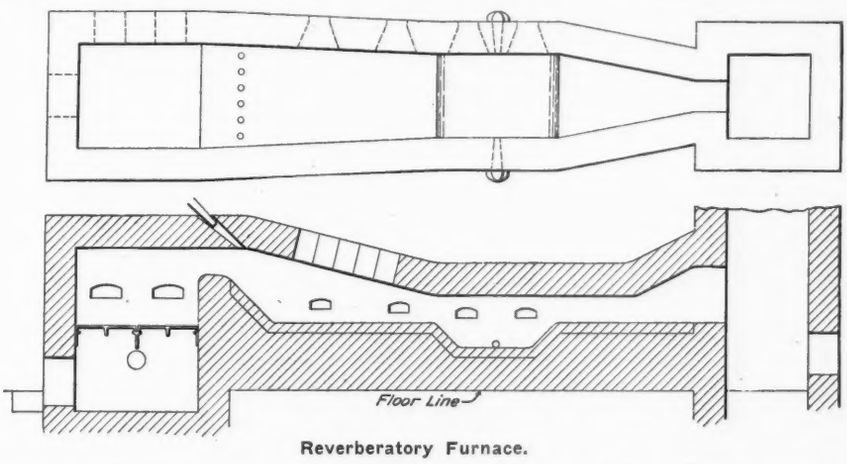
After the furnace is sufficiently cooled down the temporary brick wall in the opening is removed and the piles taken out by the charging carriage and placed on the floor, where the now annealed castings are taken out and placed in the rattlers for cleaning.

*Paper read at the April meeting of the Scandinavian Technical Society, by Mr. G. A. Akerlind, M. E., member of the Society.

If the castings are small and of delicate construction they are cleaned by being placed in wooden vats containing a weak solution of sulphuric acid and "pickled." To neutralize the acid after the pickling process, these castings are finally washed in lime water. After the annealed castings leave the rattlers they are carefully examined for cracks or other defects, and if sprung out of shape they are hammered or forced by hydraulic power to the correct shape. For such parts as are produced in great quantities—for example, like brake heads for railroad cars—steel dies are made and placed in a drop hammer. The annealing casting is then placed on the die, and one or two blows will insure its correct form. It may here be mentioned that nothing is gained by heating a malleable casting before hammering or forcing it. A temperature of 50 to 100 degrees Fahrenheit seems to be satisfactory.

I have endeavored to review the manufacture of malleable cast iron in its different stages, and I will now attempt to review some points which have a more direct bearing for the practical engineer or draftsman in considering malleable cast iron as a material of construction.

The tensile strength of malleable cast iron varies between 40,000 lbs. and 50,000 lbs. to the square inch, with an elongation in 6 inches of about 6 per cent. to 1 per cent., and a reduction of area of about 3 per cent. to ¾ per cent. respectively. This, of course, for a specially prepared test piece with symmetrical form. Let us remember that cast iron has a tensile strength of about 20,000 lbs. to 30,000 lbs. to the square inch, and is therefore about half as strong as malleable cast iron. This, however, only for tensile strength. For compressive strength cast iron is again the stronger of the two, and compares very nearly with steel. The position of a casting in a machine is oftentimes such that the definite stresses are very difficult, not to say impossible, to determine; and the engineer is here left to his own judgment, based on experience or the precedence of similar cases. If only lightness is the object for using malleable cast iron in place of ordinary gray cast iron, it is customary in railroad car construction to make a reduction in weight of 30 per cent. to 40 per cent., sometimes more. The introduction of malleable cast iron in railroad cars some 15 years ago was made more for the desire to reduce dead weight of the car than because the cast iron used was not found strong enough. The reason malleable cast iron is used to such a large extent in car construction to-day is not only the constantly increasing demand for reduced dead weight, but still more the rapid supplanting of wood by steel and the consequent substitution of rivets instead of bolts. The ductility of the malleable casting very readily permits the driving of rivets, which, as we know, cannot so readily be done with gray cast iron; and for certain parts of cars, like the journal boxes, malleable cast iron may well be considered to be supreme, leaving cast iron and "semi-steel" far behind, although for this particular detail lightness alone determines its use.



Reverberatory Furnace.

While white cast iron shrinks a great deal more in the flask than gray cast iron, and as the sections of malleable castings invariably are lighter than is the case in a similar casting of gray iron, fractures are very common, and it is therefore one of the designer's very first considerations to so arrange and distribute the metal as to meet these conditions. In pieces of an elongated shape, the stiffening ribs ought to extend lengthways so as to produce as little resistance as possible to the contraction of the metal at the time of solidification in the flask. If this be not possible, the molder provides a "crush core" with the exterior surface made of core sand in the usual manner, but whose interior is filled with crushed coke. This core barely stands handling, and when the metal solidifies in the flask it is crushed by the retarding casting and thus prevents shrinkage cracks. At other times a certain corner or junction of ribs in the casting will be found cracked. In order to prevent this a small piece of cast iron (chill) is embedded in the sand at this critical point, and the metal will cool here more quickly than elsewhere, and thus fortify this particular point, although it may happen that some other part of the casting will be found fractured instead, and in many cases the locations and the shape of strengthening ribs in the casting have to be altered until a casting is procured free from shrinkage cracks. Sometimes such defects do not appear until the casting is annealed, which, of course, entails a greater loss than if the casting had been scrapped before entering the annealing furnace.

In 1897 the writer, J. T. Carroll, designed and patented a malleable cast iron body bolster for freight cars. The malleable foundries at that time were making an effort to extend the use of malleable iron in freight car building, and so it came about that this casting of extraordinary size for such material was made for about 2,000 cars with perfectly satisfactory results. There were some failures, to be sure; but those were due to defective metal from the melting furnace, as the fracture proved, showing gray graphite cast iron. This casting was probably one of the longest and heaviest produced, and required therefore in its production special appliances, the very best material and workmanship, great care in annealing and final straightening to correct form. In the present state of the malleable foundries a casting of this kind would not be considered, and modifications in the construction of freight cars have therefore to be made with this point in view. One of the most intricate and heavy malleable iron castings made at present, as far as I know, is used by the W. H. Minor Co. in its combination draft sill and lug for a 100,000 lbs. capacity freight car, its length being 5 ft. and its weight about 200 lbs.

In conclusion, let me summarize the points I would like to emphasize regarding the designing of malleable cast iron details.

1. Endeavor to keep the metal in the different parts of the casting at a uniform thickness, depending on the size and weight of the casting. If a small casting of, say, 10 lbs. weight ¼-in. metal is about the practical thickness, $^{5}/_{16}$-in. metal is about right for a casting of 15 lbs. to 20 lbs., and ⅜ in. to $^{7}/_{16}$ in. or ½ in. for castings of, say, 40 lbs. and over. This is for freight car castings, with which I am most familiar. For commercial reasons the demand for light malleable castings sometimes forces the designer to give such dimensions for thickness of metal in his casting that the foundry cannot make it successfully, or else the manufacturer will insist on a price per pound that will protect him for the extra expense in making it and the loss due to a high percentage of cracked castings. These losses sometimes amount from 10 per cent. to 20 per cent. It is, therefore, generally better policy to modify the design to suit the foundry, although, on the other hand, these same commercial interests on your side have to be guarded as those prompting the foundry man to insist on a heavy easy casting.

2. Always endeavor to avoid sharp junctions of ribs or parts, and if the casting is long—say, 24 in. or more—bear in mind that the ends should be made of such shape as to offer as little resistance as possible to the contraction of metal when cooling in the mold.

If called upon to inspect malleable castings as to strength it is customary to break it with a sledge or under a "drop," and the difficulty of breaking it and the appearance of fracture forms the basis of opinion. A "good" casting will be found a pretty tough proposition to break. A fracture will show a distinct "skin" like wrought iron, while the interior is finely granulated, of a dark bluish color, without metallic lustre. A "bad" casting is comparatively easily broken, does not show the skin, but does sometimes a very dark bluish color, or in other cases a dark gray cast iron fracture. This is generally attributed to "poor annealing," but, as previously pointed out, if the metal in the furnace at the time of pouring does not have the right composition the resulting casting cannot be annealed. To guard against this it is sometimes practical for important castings to provide a small extension on a chunky part of the casting, where the chilling effect of the molding sand would be least and so break off this extension. The fracture will then show whether the metal is of the proper nature for annealing or not. It should be remembered, however, that there is such a thing as over-annealing; but in the present busy time this is hardly likely to occur very often.

As for pattern making, it may be mentioned that the common shrink rule, ⅛ in. to 1 ft. longer than the ordinary rule, is used. Malleable cast iron shrinks more in the mold than gray cast iron, but in the annealing process a slight swelling takes place.

The first pattern is made of wood, and from this the foundry patterns are made of aluminum, to which metal we are greatly indebted for the present growth in the malleable foundry business.

Without aluminum patterns heavier castings could not be made economically, as the old-fashioned brass patterns required two or more men to handle them. A pattern shop in a malleable foundry is nowadays a far more comprehensive institution than formerly. The wood-working department is still there, but in addition a small foundry for the aluminum castings and a machine shop with planers, shapers, lathes and drill presses, etc., will be found. As in most foundries the foreman pattern maker represents a great deal of the "brains" of the establishment, and it is generally with him the engineer has to consult in regard to the feasibility of his design or overcoming difficulties developed in the making of the casting. The facts of the matter are that it is in co-operation by the individuals concerned in the actual production of a casting, a machine or what-not, that the best results are obtained. The scientific, theoretical training of the engineer is good and proper, and in certain branches of engineering absolutely necessary; but in most cases, I think, the engineer will greatly profit by learning the observations of men who have spent long years in the shops and the foundries and by learning as far as may be the life history, if I may be permitted to use this expression, of the metals and the materials with which he is dealing; and if these notes on malleable cast iron have helped to emphasize this fact, this paper has not been read in vain.

Comparative Cost of Repairing Steel and Wooden Cars on the Harriman Lines.

Since October, 1904, there has been kept on the Harriman Lines a comparative record by months of the costs for repairing all cars of steel construction and an approximately equal number of wooden cars. The wooden cars chosen are of modern type, built about the same time as the steel cars and therefore comparable in age, capacity and kind. The figures for the first six months of the record were given in these columns last year (July 21, 1905). Below is the statement for 17 months, which brings the record down to February of the present year. Only the totals for all lines are here given instead of for each of the constituent lines as in the former statement.

	Steel cars			Wooden cars		
	Cars owned.	Total repairs.	Av'ge cost per car.	Cars owned.	Total repairs.	Av'ge cost per car.
October, 1904	11,124	$19,139.45	$1.72	10,701	$35,209.02	$3.29
November, 1904	11,159	19,459.41	1.74	10,701	31,107.18	2.91
December, 1904	11,258	20,828.33	1.85	10,676	33,385.99	3.13
January, 1905	11,258	22,348.76	1.99	10,671	34,308.70	3.22
February, 1905	11,256	26,270.60	2.33	10,660	33,578.92	3.15
March, 1905	11,255	25,290.88	2.25	10,656	36,723.35	3.45
April, 1905	11,254	24,124.18	2.14	10,650	31,024.73	2.91
May, 1905	11,554	28,063.49	2.43	10,652	37,236.75	3.50
June, 1905	11,546	29,183.00	2.53	10,642	37,656.77	3.54
July, 1905	11,546	31,909.79	2.76	10,640	40,201.93	3.78
August, 1905	11,544	31,947.90	2.77	10,634	44,459.61	4.18
September, 1905	11,536	29,609.49	2.57	10,621	42,123.48	3.97
October, 1905	12,536	33,021.66	2.63	10,615	51,556.04	4.86
November, 1905	12,539	31,765.16	2.53	10,604	45,237.82	4.27
December, 1905	12,539	35,898.61	2.86	10,603	48,186.87	4.54
January, 1906	12,536	40,207.78	3.21	10,594	50,355.97	4.75
February, 1906	12,535	33,226.91	2.65	10,583	43,870.22	4.15
Av'ge per month	11,704	$28,370.32	$2.42	10,641	$39,777.84	$3.74

These cars are classified as follows, based on the February total:

	Steel cars.	Wooden cars.
Box	2,900	6,232
Coal and ore	3,013	152
Flat	2,287	517
Furniture	297	276
Oil	871	248
Stock	2,305	2,699
Ballast and side dump	862	459
Total	12,535	10,583

The average total number of steel cars involved was 11,704 against 10,641 for the wooden cars. The average monthly repair costs were $2.42 and $3.74 respectively, a difference of $1.32, or 35 per cent., in favor of the steel cars. The average total monthly difference was $11,407, or $136,884 a year. Referring to the classification it will be observed that the wooden cars are at a disadvantage in the much greater number of box cars and the relatively small number of coal, ore and flat cars, which cost less to maintain than box cars, especially the flats. And while this causes a greater difference in the figures for average cost per car than would exist if the several classes were on an equality as regards numbers, yet considering totals this disadvantage is offset, in part at least, by the greater total number of steel cars involved. For February, for example, they were 1,952 in excess of the wooden cars, yet the total cost for repairs to the 12,535 steel cars for this month was $10,000 less than for the 10,583 wooden cars.

One interesting thing to note in both instances is the increase in the average cost per car per month over the period covered by the statement. For the first six months, as given in the previous statement, the respective average figures were $1.98 and $3.19. These increased in the subsequent year to $2.42 and $3.74, or by 22 and 17 per cent. respectively—the effect of an additional year of service. During this time 1,300 steel cars were bought (April-May and September-October, 1905), but no new wooden cars were added.

The records are being kept at the instance of Mr. Julius Kruttschnitt, Director of Maintenance and Operation, to whom we are indebted for the statement.

The Sault Ste. Marie Canals.

In view of the great interest in the type of canal which shall be adopted at Panama, and President Roosevelt's reference, in his letter on the subject to Congress, to the successful operation of the Soo canal, which led him to favor the lock rather than the sea-level type, the following description of the two canals at Sault Ste. Marie, prepared as the annual report for the season of 1905 under the direction of the Engineer officer in charge of the United States canal, is of especial interest.

Lake Superior was not connected by nature with the other Great Lakes by a navigable passage. Before the building of canals, cargoes had to be unloaded, taken across a one-mile portage, and reloaded on boats. This was the method of interchange previous to the opening of the first ship canal in 1855. The St. Mary's Rapids, which occupy the space between Lake Superior and the lower lakes, are about one-half mile wide and three-fourths of a mile long. The fall ranges from 16½ ft. to 20½ ft. The first canal built at this point was built in 1797-1798 by the Northwest Fur Company. This was on the Canadian side of the river. The lock was 38 ft. long and 8 ft. 9 in. wide, with a lift of 9 ft. A tow path was made along the shore for the oxen to track the batteaux and canoes through the upper part of the rapids. The lock was almost entirely destroyed by United States troops in 1814.

The first ship canal, known as the State Canal, was built on the American side of the river in 1853-1855. It was $1^{1}/_{12}$ miles long, 64 ft. wide at the bottom, 100 ft. wide at the water surface and 13 ft. deep. There were two tandem locks of masonry, each 350 ft. x 70 ft., having 11½ ft. of water on the miter sills and a lift of about 9 ft. each. These locks were destroyed in 1888 by excavations for the present Poe lock.

In the years 1870-1881 the Weitzel lock was built by the United States Government. This is about 115 ft. long, 80 ft. wide, narrowing to 60 ft. at the gates, with 17 ft. of water on the miter sills when the upper pool is 601.9 ft. and the lower pool 584.4 ft. above mean tide at New York. During the same period the depth of the canal was increased to 16 ft. and the mean width to 160 ft. The stone slope walls were at this time replaced with vertical face timber piers.

The Canadian canal was built on the north side of the river in the years 1888-1895. It is 1⅛ miles long, 150 ft. wide and 22 ft. deep, with a lock 900 ft. long and 60 ft. wide, and with 22 ft. of water on the miter sills.

The Poe lock was built by the United States in the years 1887-1896. It is 800 ft. long, 100 ft. wide, and has 22 ft. of water on the sills. Since 1892 the American canal has been deepened to 25 ft., and its entrance piers extended so that its total length at the falls is 1⅜ miles. Its width is variable, being 500 ft. at the upper entrance, 108 ft. at the canal gate, 270 ft. at the basin above the locks, and 1,000 ft. at the lower entrance.

The canal also practically includes those parts of the channels through the St. Mary's river which have been improved through shoals of sand, clay, boulders, sandstone and limestone. The first appropriation for improving the channels was made in 1856. The draft was made 12 ft. in 1857-1866 and 1866-1869. Between 1879 and 1883 the depth was increased to 16 ft. The Hay Lake route was improved for a depth of 20 ft. at mean water in 1882-1894. Betterment of the channels has been steadily continued since that time, so that the dredged areas now amount to 34 miles in length, with a minimum width of 300 ft., increasing at angles and other critical places to 1,000 ft. In 1903 excavation of channels was begun for 21 ft. at low water. The accompanying map shows the situation of the canals and locks.

The cost of the different improvements has been about as follows:

Locks and canal of 1855	$1,000,000	Improving channel through river	$5,000,000
Weitzel lock	1,000,000		
Poe lock	3,000,000	Canadian lock, canal and approaches	5,000,000
Widening and deepening channel	3,000,000		

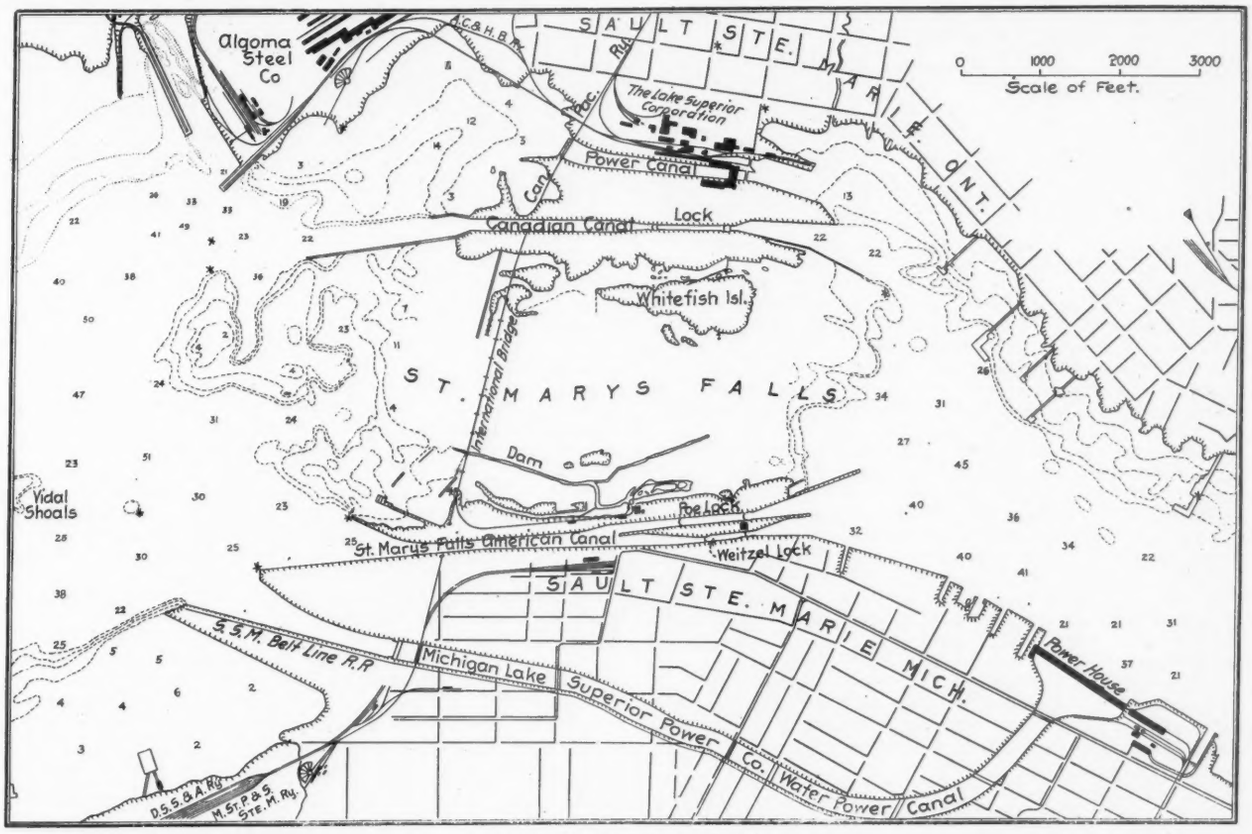
The American locks are operated by hydraulic power with a pressure of 115 lbs. to the square inch for the Weitzel lock machinery and 200 lbs. for the Poe lock machinery. The Canadian lock is operated by electricity, generated by water power. The Poe and Weitzel locks can be filled or emptied in about seven minutes, and the gates opened or closed in two minutes. The Canadian lock can be operated in about eight minutes. An up-lockage of a single boat 350 ft. long has been made through the Poe lock in 11 minutes. The average time, however, spent in making a lockage last year was about 29 minutes, due to the slow movement of boats while entering and leaving the locks. As many as five boats were often included in a single lockage. The average time of lockage through the Canadian lock was 15 minutes. The average time of passage

per ship was one to six minutes less than the average time of lockage.

From 1855 to 1888 the canal was controlled by the state of Michigan, and tolls charged to cover expenses, the rate at first being 6½ cents per registered ton. This was gradually reduced to 2½ cents, and the minimum charge for lockage of a boat similarly reduced from $5 to $3. Since the transfer of control to the United States in 1881, use of the American canal has been free, nor does the Canadian canal collect tolls for either foreign or domestic commerce. The expenses for the St. Mary's Falls canal (the American canal) were in 1905 $64,424 for operating and $20,822 for repairs; total, $85,246 for the year. This is at the rate of 2.48 mills per freight ton. The previous year, when much less traffic passed through the canals, the total cost was $93,248, or 4.25 mills per freight ton.

During the 51 years the canal has been in commission the growth of Lake Superior commerce has been enormous. The yearly traffic has increased from a minimum of 14,503 tons in 1855 to 44,270,680 tons in 1905, the high record. The increase of each year's tonnage over the preceding year has averaged about 20 per cent. In the decade 1895-1904 the traffic was over 253,000,000 tons, against 80,300,000 tons in the preceding decade. Last season's traffic shown by the change in the class of freighters used in the Lake Superior traffic. Until the year 1904 there was no vessel over 500 ft. long, or which carried over 9,000 net tons. In 1904 one vessel between 500 and 600 ft. long was put in service. On a capacity basis three vessels with a capacity of between 9,000 and 10,000 tons and one which carried over 10,000 tons were put in commission that year. In 1905 there were 28 new vessels put in commission for the Lake Superior trade, all freight steamers from 250 to 569 ft. long. Against the one vessel between 500 and 600 ft. long in 1904, there were last year in service 23 vessels over 500 ft. long and with 56 ft. beam. Against the four vessels in 1904 which carried over 9,000 tons, there were in 1905 14 vessels carrying between 9,000 tons and 10,000 tons, 10 vessels carrying between 10,000 and 11,000 tons, seven vessels carrying between 11,000 and 12,000 tons, and three vessels carrying 12,000 net tons and over—a total of 34 vessels carrying over 9,000 tons. This is a striking exhibit of the increased size of vessels which are being used, and especially of the great progress which has been made within the last year in the size of lake freighters.

For a single cargo, the steamer E. H. Gary, of the Pittsburg Steamship Company (United States Steel Corporation), holds the season's record of 12,368 net tons. The barge John Smeaton, owned


Algoma Steel Co
C.& H. B. Ry.
S A U L T S T E. M A R I E, O N T.
0 1000 2000 3000
Scale of Feet.
The Lake Superior Corporation
Power Canal
Can.
Canadian Canal
Lock
Whitefish Isl.
International Bridge
S T. M A R Y S F A L L S
Dam
Vidal Shoals
Poe Lock
St. Mary's Falls American Canal
Weitzel Lock
S A U L T S T E. M A R I E, M I C H.
S.S.M. Belt Line R.R.
Michigan Lake Superior Power Co.
Power House
Water Power Canal
D.S.S.&A.Ry.
M.St.P.&S. Ste.M.Ry.

The Sault Ste. Marie Canals

of 44,270,680 net tons shows an increase of 12,724,574 tons, or 40 per cent. over 1904.

The American canal opened last year on April 14, and closed December 16. The season of navigation lasted 8 months and 10 days. The traffic through the American canal was 88 per cent. of the total freight, an increase of 46 per cent. over the preceding year. American vessels carried 95 per cent. of the total freight traffic.

Of the freight carried, cereals furnished 28 per cent., and iron, including iron ore, 27 per cent. In other words, the two principal articles of traffic were wheat and iron ore. There were 68,000,000 bushels of wheat carried, against 50,000,000 in 1904, and 31,000,000 tons of iron ore, against 19,000,000 in 1904. Of the total of 44,000,000 net tons passing through the canals, iron ore furnished about 70 per cent. The 31,000,000 tons were valued at about $94,000,000. Iron ore tonnage showed an increase of 60 per cent. and wheat of 37 per cent. over the previous year.

There has been a great reduction in freight rates for water transportation to and from Lake Superior in recent years. In 1887 the rate on coal was 90 cents a ton. In 1905 this had dropped to 33 cents a ton. Wheat cost 7 cents a bushel in 1887 against 2.3 cents a bushel in 1905. The rate on iron ore in 1887 was $1.75 a ton. It is now 68 cents a ton. On general merchandise the rate has in the 19 years decreased by half, from $4 to $2 a ton.

The main cause of the great reduction in freight rates is clearly by the same company, holds the single cargo record for barges of 9,184 tons. The steamer Augustus B. Wolvin, of the Acme Steamship Company, which in 1904 held the record for maximum single cargo, total cargoes and ton miles, retained last year the two latter records. Its total cargoes amounted to 274,401 net tons, and its ton miles to 249,038,482. The steamer Duluth, of the Western Transit Company (N. Y. C. & H. R.), has the maximum record for the season's run, with 41,374 miles.

Gasolene Motor Cars for Railroad Use.

Mr. William P. Kennedy in an article in the May issue of *Motor Traffic* gives some interesting facts in regard to gasolene cars and engines for railroad use. He states that the serious attention given the gasolene railroad car by prominent railroad companies of this country indicates that within the immediate future we may expect some practical development to prove the utility of the self-propelled car in certain branches of railroad service. Opinions differ as to the scope of its usefulness, but its practicability is generally conceded in view of its regular employment abroad and the preliminary work already done in this country.

On branch lines in isolated districts, where the service is intermittent, the cost of maintenance and operation of a locomotive and

one or two cars is far in excess of the revenue, and the gasolene motor car is certain to make such lines remunerative, the labor required being materially reduced and the fuel consumption being proportionate to the work performed.

Like all other innovations, however, the motor car proposition is meeting its share of antagonism. In its mildest form this appears in the scepticism expressed by the older type of railroad man, who has "run the gauntlet" in the development of the present steam locomotive, and who does not believe that any vest-pocket motor can share in the same class of work. In his opinion, the gasolene motor may be all right as a necessary adjunct to the automobile, which is a toy and a luxury at the best, but that it can ever legitimately undertake the performance of real hard railroad work at a profit is dubious in the extreme. The cars which have proven to be impractical it would be unfair to criticize or describe, since they are the result of honest effort on the part of the well-trained mechanical engineer experienced in ordinary railroad work, but unfamiliar with the peculiarities of gasolene engine construction and operation.

It is generally conceded at the present time that the most effectual solution of the proposition will be to have each of the various parts required designed and developed by independent manufacturers, whose experience in these various lines qualifies them to insure the performance required. It is no more expedient or even feasible for a railroad to design and build gasolene engines in its own shops than it would be to attempt to efficiently make its electric motors. Where the engine is to be placed depends largely upon the form of transmission employed. If electric transmission is used the engine with generator attached must occupy a section of the car body. If mechanical transmission is used the engine may be placed either up in the body, on the truck and partially protruding through the car floor, or self-contained on the truck end and entirely independent of the body. It is quite possible to place a 150-h.p. engine measuring 85 in. long by 40 in. high and 30 in. wide and weighing 2,000 lbs. on the front truck, and not exceed the standard 90 in. wheel base with 5 in. clearance above the top of rail. The advantages of placing the engine on the truck are many. The truck and power equipment can be constructed independent of the type of body to be used, and the suspension and drive are more positive and effective than when the engine is placed in the car. The engine and mechanism are accessible and the general features are more in line with what has proved successful in automobile practice.

Every car at present in existence has a different size and type of engine, and a varying form of transmission, and each has its temporary advocate, as was the case at the beginning of the automobile industry. The engines in use vary in size and weight from a 150-h.p., 3-cylinder, 13½ in. x 16 in., 325 r.p.m., weighing 35,000 lbs., down to a 75-h.p., 6-cylinder, 8 in. x 10 in., at 400 r.p.m., weighing 4,000 lbs. It is quite possible to do the work of the former with an engine having 8 cylinders, 7 in. x 6½ in., at 1,000 r.p.m., weighing 2,000 lbs., and that of the latter with a 4-cylinder engine, 7 in. x 6¼ in. at 1,000 r.p.m., weighing 1,050 lbs.

At present cars are under construction equipped with these last-named engines, whose performance will undoubtedly go far to demonstrate that the nearer railroad men approach and take advantage of the practice of automobile constructors, the more rapid will be the development of the self-propelled railroad car.

The Coal Traffic Inquiry.*

At Washington, on June 1, the Interstate Commerce Commission resumed its inquiry into the relations of railroads with coal and oil companies, and took the testimony of E. T. Postlethwaite, of the Pennsylvania; J. E. Muhlfeld, of the Baltimore & Ohio, and others. Mr. Postlethwaite had disposed of his coal company holdings two years ago. Mr. Muhlfeld was questioned with a view to showing that the H. C. Frick Coal & Coke Co. had been favored by the Baltimore & Ohio in repairing the coal company's cars. The evidence tended to show that favors had been granted, but it was not at all definite. A coal dealer of Washington charged that he was unable to bring coal from West Virginia to Washington because the railroads had agreed to exact $3.20 a ton, while at the same time a rate of $1.10 had been granted to favored shippers.

At Philadelphia, June 5, officers of the New York Central were heard concerning the relation of that company to the Beech Creek Coal & Coke Co., which has now been absorbed in the Pennsylvania Coal & Coke Co. The New York Central acquired 5,000 shares of stock in the B. C. Co. in 1901, as a consideration in the contract which it made for carrying the coal from the mines, paying no cash. The coal company agreed to mine a million tons a year and the railroad agreed to furnish cars enough for that quantity. The road also agreed to buy 500,000 tons of coal for its own use, this apparently in addition to the million tons first mentioned. The New York Central owns the Clearfield Bituminous Coal corporation, formed to supply the road with fuel, and also the Gallitzin Coal Co.

Vice-President Rossiter said it was against the policy of the company for officers to hold coal stock, but there was no absolute rule. General Manager Smith, General Superintendent Bradfield, and other officers, testified that they had no ownership in coal or coke companies. C. H. Ewings, Superintendent of Freight Transportation, testified about the distribution of cars to different shippers. The company has never refused to inform a coal company as to its rating. John H. Herchardt, Secretary of the Buffalo, Rochester & Pittsburg, testified that the company owned nearly all of the coal companies on the middle and Pittsburg divisions of the road and produced 90 per cent. of the tonnage shipped over the road.

*See page 527 (May 25), and page 554 (June 1).

Rifled Pipe for Pumping Heavy Crude Fuel Oil.

BY JOHN D. ISAACS.
Consulting Engineer, Bridges, Buildings and Signals, Union Pacific System.

The crude oil product of most of the California fields is a very heavy, thick and viscous fluid with an asphalt base. The entire product of the Kern river fields, near Bakersfield, is particularly heavy, its density averaging about 14 deg., Baume.

Up to the present time, this oil has been transported from the fields in cars, but attempts have been made to facilitate its movement by long pipe lines. These trials met with little success as it was found necessary to use very high pumping pressures, necessitating expensive pipe, powerful pumping plants and these plants so close together that operating expenses were prohibitively high for practical economy, while even with such a plant the delivery is very small.

Various attempts have been made to overcome these difficulties, the most important of these being to heat the oil. This was a decided help in short pipe lines, but a temperature sufficient to be effective for long distance pumping caused the disintegration of the oil and the deposit of asphaltine, called by the oil men "carbonizing," clogging the line.

Water was introduced with the oil, but as much as 30 per cent. of water was needed to materially improve the results and the surging of the mixture through the line soon caused an emulsion of the oil and water, very difficult and expensive to separate, necessitating heating the oil to 180 deg. Fahr. for this purpose.

The mixing of the lighter oils with the heavy oils has made it possible to pump the mixture, but in the fields where only the heavy oils are obtained, this necessitates the pumping of the light oils to such fields from long distances and the mixing of the oils causes a loss in the value of the light oils, which have a market value much higher than the heavy fuel oils, making the process very expensive.

A new process has been adopted by the Southern Pacific Co. which has led to the construction of a "Rifled Pipe Line." The method is to rifle the pipe, giving it an interior appearance similar to that of a rifle barrel. A small percentage of water is pumped with the oil. The rifling of the pipe causes the entire liquid mass to whirl, and as the water is heavier than the oil, it is thrown to the exterior of the mass, causing the envelopment of the oil with a thin shell or film of water. This forms a water lubrication between the oil and the pipe, greatly reducing the friction and allowing the plug or core of oil to glide through the pipe readily.

When this principle was discovered the first experiment was made with a small lead pipe. In the process of drawing ordinary lead pipe, the interior surface is slightly scored in close longitudinal lines. The pipe was first used as received and friction co-efficients determined; it was then twisted by hand, causing these longitudinal scorings to become helical. This was sufficient to cause a rotation of the oil and water when passed through the pipe. Experiments made with this rifled lead pipe indicated the soundness of the principle and led to an experiment on a larger and more practical scale. One-half mile of 3-in. standard line pipe was used in the next experiment, which was performed by the Southern Pacific Co. at West Oakland. The pipe was first rifled by the insertion of helical wires. This was accomplished by simply drawing tempered steel wire from a coil through the pipe in lengths of 500 ft. at one time, the spring of the wire causing it to cling closely to the sides of the pipe, forming a helix. This pipe was then laid and subjected to an exhaustive experimental operation with heavy Kern oil.

The best results were obtained by pumping about 10 per cent. water with the oil. A flow was obtained many times that obtained by pumping pure oil, or oil and water, through an ordinary plain pipe. The 3-in. line was rifled by passing the pipe through a series of rollers, to a pitch of 1.5 with the line of the pipe. (See description of rifling machine which follows.) Experiments on this line gave even better results and lower co-efficients than those from the lead pipe and justified the construction of a practical rifled pipe line for transporting oil commercially.

A pipe line was finally built, 31.17 miles long, between Volcan,

a point located centrally in the oil fields, on the Southern Pacific, and Delano, another station northward on the same railroad at an elevation of 120 ft. below Volcan. The pipe used was standard 8-in. line pipe, weighing 28.2 lbs. per foot, fitted with recessed line couplings and tested to 1,200 lbs. per sq. in.

The pipe was rifled in the following manner: The machine is shown in the accompanying sketch; the large discs "A" and "B" carry six rollers each, mounted in roller fork bearings. The central disc "C" is a floating disc, to which are attached wedges "w"; these wedges tapering outward on both sides of the disc, one wedge opposite each roller fork, and engaging with the fork. When the discs "A," "B" and "C" are apart, the rollers are open wide enough to allow a pipe coupling to pass freely between them. By means of the pulling rods "P" operated by the lever "L" the three discs are drawn together to any limit set by the adjustable stud bolts "S." This drawing together of the three discs causes the wedges to thrust the roller forks toward a common center, this is, indent them into the pipe to any desired depth. The rollers were set at a pitch of about 1.5 with the line of the pipe. The discs are so spaced that each roller in disc "A" lines up with the one just to the right in disc "B," so that when the pipe is drawn through it rotates one-sixth of a turn between the two discs. Thus, for one turn of the rifling in 10 ft. of pipe, the discs would be one-sixth of 10 ft. apart in the closed position, or 20 in. Circumference of pipe is about 25 in., so pitch of rollers to correspond to one turn of rifling in 10 ft. would be as 25: 120.

Each length of pipe was fitted with a pulling plug on the male thread, having an air vent, and a testing plug on the coupling end by which water was introduced. The pipe was filled with water, the pressure raised to 1,200 lbs. and then released. If the pipe stood the test satisfactorily, it was placed in the rifling machine. The rollers were closed just behind the pulling plug, the rollers indenting the pipe to a depth of 3-32ds of an inch. By means of a hoisting engine and a pair of triple blocks reeved with a seven-eighths inch steel cable, the pipe was drawn through the machine. The rollers described six helical paths around the pipe, one complete turn in each 10 ft. The rollers were then opened, the pipe drawn out, and subjected to 1,200 lbs. water test. During the operation of the machine, the rollers were flooded with lubricating oil. The result was a pipe spirally indented and having the appearance of being rifled when looked into at one end.

The line is now laid in a ditch to a depth of about two feet, and screwed together by four pair of eight inch lay tongs handled by 16 men. The ditch was dug about 18 in. wide and the pipe laid zigzag within the easy elastic bending of the pipe to provide for expansion by heat. In the vertical plane, the pipe is also laid with a vertical zigzag or wave of about 400 ft. long or shorter. The depth of these waves is about the diameter of the pipe so as to form traps at 400 ft. intervals. The object of the traps is to accumulate water at frequent intervals when the line is shut down, preventing the formation of a long plug of solid oil, and facilitating the restarting of the line.

The pumping station consists of three 200 H.P. boilers of the return tubular type fitted with water heater, duplicate feed pumps and pressure burners. The main pump is a compound duplex steam pump, 25-in. and 42-in. steam cylinders with 9½-in. oil plungers with 36-in. stroke.

The auxiliary water pump is a duplex plunger steam pump, 16 in. steam cylinders, 5-in. plungers and 12-in. stroke. The oil supply tank is 30 ft. higher than the pump and a 27-in. suction pipe used, about 100 ft. long, insuring an ample supply for the pump.

The water is injected by means of a special injection nozzle. A piece of 7-in. well casing is introduced inside the 8-in. pipe; oil passes through the inner pipe and water is introduced through the annular space between the two pipes, both starting off in their proper relative position. A short baffle, or twisted plate, is placed in the inner tube at this point to give the oil an initial whirl.

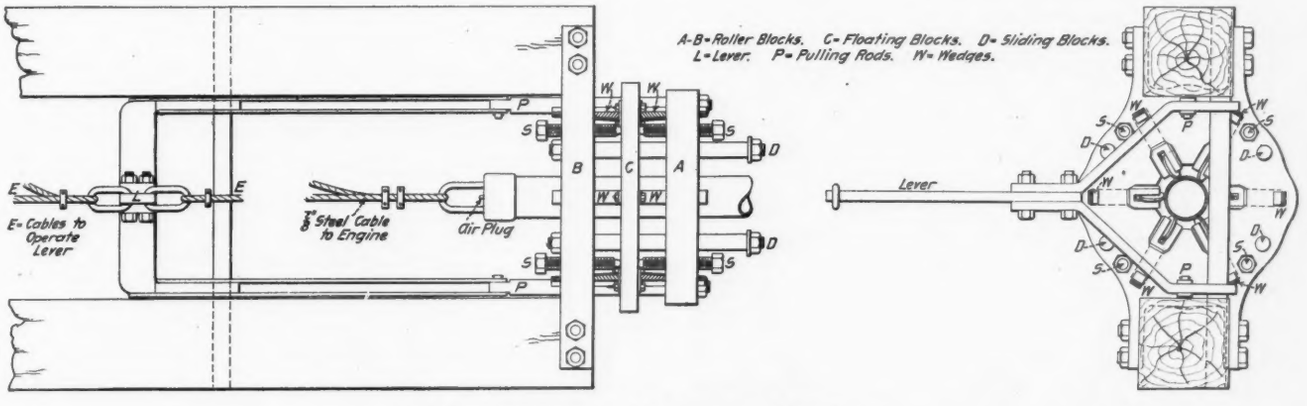
The line was first tested with water and all breaks and leaks repaired until the entire line held 1,000 lbs. pressure. The line was next subjected to a continuous operating test, lasting 24 days. During this run an average of over 14,000 barrels net oil in 24 hours was obtained for the entire run at an initial pressure of 800 lbs. per sq. in. For several hours at various parts of the test over 675 barrels of net oil per hour was pumped at 800 pounds.

The oil furnished was exceptionally heavy and had stood for a long period in an earthen storage reservoir so that much of its light constituents had evaporated. The temperature of the oil was all below 60 deg. Fahr. when received at Delano, and in no case was over 75 deg. Fahr. when received at the pumping station, averaging much lower. Experiments show that the maximum flow of oil was obtained when about 10 per cent. of water was used.

At the end of the line, the water and oil were found entirely separate and where run into the settling tanks, the water was easily bled off, leaving only about 1 per cent. in the oil shipped.

General View of Rifling Machine.

Rifling Machine for Pipes 5 in. to 9 in. in Diameter.



Rifling Machine for 8-in. Standard Line Pipe.

From Delano the oil was shipped away in cars for commercial use. For comparison with water flow, we use the formula:

$$p = \frac{K\ v^2}{d};$$

p = fall in pressure per 100 ft.;
d = diameter of pipe in inches;
v = velocity in feet per second;
K = constant of flow.

This formula does not hold good for all cases and is used for the purpose of comparison only for the flow of oil and water through the same pipe line.

8-inch Plain Pipe, Not Rifled.

Straight oil, no water, average	K =	70.00
90 per cent. oil + 10 per cent. water, average	K =	41.00

8-inch Rifled Pipe.

90 per cent. oil + 10 per cent. water, average	K =	00.49
90 per cent. + 10 per cent. water, best result	K =	00.37

3-inch Plain Pipe, Not Rifled.

Straight oil, no water, average	K =	148.00

3-inch Rifled Pipe.

90 per cent. oil + 10 per cent. water, average	K =	00.33
90 per cent. oil + 10 per cent. water, best result	K =	00.25

Any Pipe Above.

Straight water, no oil, average	K =	00.18

The results show that the rifled process increases the flow of net oil through a long pipe line 8 to 10 times that of the plain pipe under similar conditions as to diameter of pipe, pressure, etc.

While the values of "K" for the 8-in. pipe are considerably larger than those for the 3-in. pipe for the rifled process of pumping, the faults developed in the Volcan-Delano line indicate plainly that in future lines the rifling may be so modified as to bring the value of "K" down to at least that shown by the 3-in. line.

Among the anticipated difficulties which did not develop were:

1st.—The difficulty of starting after stopping.

2d.—Emulsification of water in the oil.

3d.—Reversal of density under pressure of the oil and water. This was at one time regarded as a probable serious obstacle due to the fact that the oil is quite compressible (which, by the way, has considerable bearing on the facility in starting). It was surmised that possibly under pressure with an elastic oil approximating so closely to the density of water, that their densities might be reversed, in which case the application of the theory would fail in practice. Experiments were made on this phase of the matter by filling a pipe with oil upon a layer of water, the relative percentage being about that which was expected to be used in pumping. The pressure was then raised to various points and the pipe reversed awhile so as to see whether from a practical experiment such an obstacle actually occurred. From these experiments and theoretical considerations, it was determined that the density of the oil became the same as that of the water at pressures very greatly higher than those that would likely be used for such purpose.

4th.—The possibility was anticipated that the joints in the pipe (when the ends are screwed into the couplings, there is left a space of about ¼ in. between the two ends) might produce a turbulent flow and neutralize or destroy the separating effect of the centrifugal action upon the mass of oil and water. In practice it was found that such action did not take place and that this annular space was filled with a more or less permanent washer of water and the flow was still as definitely helicoidal as if the annular space had been filled, as it was in some experiments, with a lead washer carefully scraped out to the diameter of the pipe.

The above conclusions are not altogether surmised from results; but have been clearly visible by the introduction at intervals in the three-inch half mile pipe line, laid at Oakland, of sections of heavy glass pipe through which the action in starting, rotating, etc., was clearly observable.

This system of pumping fluids is the joint invention of Mr. John D. Isaacs, consulting engineer of the Harriman lines, and Mr. Buckner Speed, superintendent of pipe lines, Southern Pacific Co., and was developed after many attempts to accomplish the same result by other methods.

Canadian Railroad Notes.

Ottawa, June 2, 1906.—The bill to incorporate the Toronto Union Station Company was ordered reported by the Railway Committee of the House of Commons on May 31. It creates a corporation of which Sir Thomas G. Shaughnessy, Charles M. Hays, David McNicoll, E. H. Fitzhugh, Francis H. McGuigan and James Wm. Leonard are charter members. The capital is to be $2,000,000, and bonds to the amount of $3,000,000 may be issued. The purpose is to erect a union station at Toronto for the use of railroads entering the city.

In July the National Transcontinental Railway Commission will call for tenders for construction of the line from Quebec to Moncton. There are now nine survey parties in the field.

Mr. Frank W. Morse, General Manager of the Grand Trunk Pacific, has just returned from a six weeks' inspection trip in the west. He comes home more delighted than ever with the prospects. In speaking of the vast amount of surveying which has been done, Mr. Morse says that the difficulties met with were far greater than had been expected. On the Pacific and New Ontario sections the work was very difficult. Despite this he believes that the road will be in operation long before the time specified. Mr. Morse was waited upon at many stopping places during his trip, and particularly in Carberry, Manitoba, was he urged to bring the Brandon branch of the road through that town.

A man is at present in Ottawa endeavoring to secure 1,000 men to work on Mr. Hill's railroads in the vicinity of Brandon, Manitoba.

Higher Technical Education in Germany.

During the past 30 years, in which German industrial development has been so rapid that it has outstripped the other European nations, technical instruction has increased to such an extent that it has far surpassed that of France. Without mentioning those industrial schools which care for the formation of practical men and workmen, there are *technische hochschulen* (technical high schools) in most of the capitals of the Confederation such as Berlin (Charlottenburg), Dresden, Munich, Hanover, Dantzig, Darmstadt, etc., which give diplomas to a regular army of engineers every year. The quality of the instruction and the perfection of the equipment of these schools are new and beyond compare. But the desire to enter upon the career of an engineer has exceeded the industrial development, and there is now a crisis in Germany that is perhaps more acute than that in France.

According to a statement in the *Zeitschrift des Vereins Deutsches Ingenieurs*, "in consequence of the democratization of the various classes of engineers, architects, chemists, etc., and their overproduction, accompanied by that industrial concentration which does away, more and more, with independent workers and transforms them into salaried servants of the great establishments, it is becoming more and more difficult to find employment." For example, the high schools admitted 5,432 students in 1890-91, and 15,866 in 1904-05; the faculties in the courses of natural sciences had 1,100 pupils in 1892 and 3,015 in 1905; the professional schools of mechanics of Prussia had 755 students in 1891 and 3,011 in 1903, and so on. According to statistics, only about 50,000 technicians of all classes are employed in German industries, so that one can readily see what there is for the last comer.

Hence while the wages of workmen and subordinates are gradually improving, the salaries of the technicians are falling with the increase in the number of men available; the relations between them and their employers are becoming less cordial and the discontent is general and persistent. Conditions more severe than those put upon ordinary workmen are also imposed; such, for example, as five years for the clause "deconcurrence" (the time during which the employee must not get to an establishment similar to that which he has left), while the legal prescriptions are that there shall be a delay of three years, which is not obligatory if the employer has without sufficient cause discharged him or has not fulfilled all of his engagements.

These circumstances have aroused among those interested a movement towards organization whose outward manifestation is the formation of a union of technical employees, which proposes to attempt to improve the working conditions of its 3,000 members, whose number is constantly increasing. According to a bulletin drawn up under its auspices, it asks for: A day of eight hours with extra pay for overtime; no work on Sunday; a vacation of six weeks; payment for every month; suppression of the "deconcurrence" clause in contracts; arrangements for the procuring of patents by engineers, independent of the employer; reform in the procedures regarding industrial employees; participation in insurance of state workman's pensions.

The example of this unfortunate condition is being used in France by those who are opposed to the multiplication of institutions of higher technical instruction in that country. This same party is opposing the courses already created, and urging the limitation of diplomas conferred on chemists and others, as well as the creation in Paris of a fifth Ecole des Arts et Metiers, or a school of electricity, which is agitated on all sides, since it would soon result in an overproduction that would condemn too large a number of intelligent men to idleness and misery. *La Nature.*

On a local railroad in Germany a pair of birds, there called "redtails," built a nest in a baggage car, which is hauled every morning, loaded chiefly with cans of milk, from Marbach to Beilstein, and back in the evening to Marbach. In this nest the hen bird has laid four eggs, and sits on them undisturbed by the clatter of the milk cans as they are loaded and unloaded. The cock bird keeps her company on the trips, and forages at the termini. He never misses his train.

GENERAL NEWS SECTION

NOTES.

In July, when the Shoshone Indian Reservation lands are to be opened for settlement, the Union Pacific will run a line of automobiles from Rawlins, Wyo., its nearest station. The line is 100 miles long.

The Brooklyn Rapid Transit Company, operating the street surface railways in Brooklyn, N. Y., has just established 62 transfer posts, at which agents will be on duty night and day to give free transfers to passengers changing cars who are entitled to them.

Two of the robbers who held up a Canadian Pacific express in British Columbia, May 9, have been tried and sentenced to imprisonment for life, and a third has been sentenced for 25 years. One of the culprits has only recently ended a 20-year term of imprisonment in California.

The State Railroad Commission of Texas on May 30th issued an order directing the Houston & Texas Central to reduce its passenger fares to the basis of 2.5 cents a mile. It is said that the road will take all legal means to resist the enforcement of the order. A reduction on this line would force reductions on a number of others.

The "Lincoln party," an independent Republican organization recently formed in Pennsylvania, held a convention May 31 and nominated candidates for Governor and other state officers. A platform was adopted advocating numerous reforms, among which is more complete control of the railroads; and this clause calls for the creation of a state railroad commission, with powers similar to those of the Interstate Commerce Commission.

The Pennsylvania Railroad is now transferring cars by floats regularly between its freight terminal at Greenville, N. J., on the west side of New York harbor, and the Bush terminal at Thirty-ninth street, Brooklyn, on the east side of the harbor. The Bush terminal grounds and docks are extensive, a dozen or more steamship lines making it their freight headquarters, and freight is transferred directly from freight cars to ocean steamers.

In the United States Court in New Mexico, last week, the Grand Jury brought in a number of indictments against the Atchison, Topeka & Santa Fe for violation of the Interstate Commerce law. It is said that the indictments, which are accompanied also by indictments of the Colorado Fuel & Iron Company, have to do with offences similar to and perhaps connected with those which figured in the Interstate Commerce Commission investigation a year or more ago.

Albert Roath, passenger conductor between Worcester, Mass., and Norwich, Conn., on the Norwich & Worcester division of the New York, New Haven & Hartford, has completed 50 years of service in that position on the same road, and his service with the company began eight years earlier, when, as a farmer boy, he helped clear up the wreck of a freight train and concluded that he would like to go into that kind of business. Mr. Roath is only 78 years old and is erect and clear-eyed. He has never had an accident to speak of.

By the explosion of a steam pipe in the 96th street power house, on the morning of June 1, surface street cars of Manhattan, New York city, were brought to a standstill and delayed several hours on the Sixth, Seventh, Eighth, Ninth, Tenth, Second, Third, Lexington and Madison avenue lines, and the Eighth, Fourteenth, Twenty-third, Forty-second, Thirty-fourth, Eighty-sixth and 116th street crosstown lines. These lines, all depending on a single power house, are very extensive, and the number of passengers who were obliged to take passage on the Subway or the elevated lines aggregated many thousands.

The Appellate Term of the Supreme Court of New York has sustained a lower court in declaring illegal a rule of the Nassau Electric Railroad Company that a passenger entitled to a free transfer must, in order to secure the privilege, apply for the transfer at the time he delivers his ticket or his fare to the conductor. A passenger who did not promptly ask for his transfer sued the company for the $50 statutory penalty and he wins his suit. The court says that the railroad may make reasonable regulations, but that this rule does not come within that class; from which it would appear that the court sees no hardship in requiring a street railroad to give identification checks to each passenger—for how otherwise can a conductor, after passengers have mingled with each other, decide which of them are and which are not entitled to transfers?

Illegal Commissions to Refrigerator Car Co.

In the United States Circuit Court at Milwaukee May 31, a decision was rendered, prepared by Judge Baker, holding the Milwaukee Refrigerator Transit Company and six railroads guilty of violating the Interstate Commerce law in giving and receiving unlawful rebates. The Pabst Brewing Company was found not guilty. The railroad companies, the Wisconsin Central, the Pere Marquette, the Erie, the Chicago, Rock Island & Pacific, the St. Louis & San Francisco, and the Chicago & Alton, with the refrigerator company, were charged with manipulating rates so that shipments of beer from the Pabst brewery were carried for 10 per cent. to 12 per cent. less than the regular rates. The facts were admitted; but it was claimed that the discount was not illegal because it was in the nature of a commission which the railroads paid to other freight solicitors on the same basis as to the refrigerator company. The railroads paid the commission to the refrigerator company to secure the business, apparently for years, the evidence showing that roads refusing to pay the commission received none of the traffic in question; and the benefit received by the refrigerator company was partly or wholly made over to the brewing company, for the reason that the refrigerating and the brewing company were controlled by substantially the same persons, although the organizations were distinct. The opinion was concurred in by Judges Grosscup, Seaman and Kohlsaat.

Record of the "Twentieth Century" Express Trains.

In 176 trips made by the Twentieth Century Limited of the New York Central and the Lake Shore, between New York and Chicago, since March 1 the train has arrived at destination on time 151 times. On 16 trips it has arrived less than 30 minutes late; on five trips it was from 30 minutes to one hour late, and on four it was over an hour late. The regular train westbound consists of four cars all of the way, with a fifth, the dining car, part of the way for dinner and breakfast. Eastbound the regular train has five cars, or six with the dining car. In making the 176 trips above mentioned, 53 extra cars were hauled, and at the present time the eastbound train has seven cars every day from Albany to New York.

Eleven Passengers Killed Near Providence.

On Sunday morning last about 1 o'clock the derailment of an electric car at Moore's Corners, East Providence, R. I., resulted in the death of 11 and the injury of about 75 of the 100 passengers in the car. This was a special car carrying a picnic party and was in charge of a motorman who, it is said, was making his second trip over this line. In descending a steep grade which terminated at the bottom in a curve, he allowed the car to go too fast and it was overturned at the curve by reason of the excessive speed. It is said that an arc lamp at the foot of the hill, usually lighting the street at that point, was not burning.

Marley Not Like Rockefeller.

The Interstate Commerce Commission in an opinion by Chairman Knapp, has announced its decision in the case of Marley against the Norfolk & Western and others. There are two routes over which coal may be shipped from the Thacker district in West Virginia to Alexandria, Ind., one by the N. & W. and C., C., C. & St. L., the shorter line, and one by the N. & W., Hocking Valley and Lake Erie & Western. The complainants in 1903 had shipped to them eight carloads over the latter route. By that line the published rate was $1.90 a ton, while over the other route it was $1.65. On Nov. 26, 1903, the rate by the route used was reduced to $1.65, and later the other line lowered its rate to $1.55. The complainants demanded reparation. The evidence related only to the rate itself, and to the fact that a lower rate was in force over a competing short line. The Commission holds that the rate charged is not shown to have been unreasonable, and that in view of their published tariff the carriers in the through line over which the coal was carried could not lawfully apply the lower rate which was in effect over the competing line.

A Psalm of (20th Century) Life.

Lives of railroad men remind us
We are fools to work for pay,
When from the air and all around us
Stocks and bonds may come our way.

—*Minneapolis Journal.*

Violation of Rule 106.

By a strange freak, several cars of a Big Four freight train, which passed through this place at 2 o'clock this morning, left the rails at the Pennsylvania street crossing, ran six blocks off the rails, in places four feet from the rails, and then took the track without the train crew knowing of the accident until they reached

Prescott, five miles east of here. The cars in their wild career tore more than half the station platform off, cutting through it like a knife, knocked down a stand pipe which flooded the town for blocks before it could be turned off and side-wiped a string of box cars which stood on a siding. Brakeman H. C. Wilson leaped from the moving train when the cars left the tracks and remained in Shelbyville. At Prescott the train was stopped to investigate his absence and all cars and trucks of the train were found on the track. Wilson was standing on a car just ahead of the first one that jumped the track. He thought the whole train was going off, and so jumped for his life. One oil box and a car body were slightly damaged.—*Shelbyville (Ind.) Republican.*

The President's Train.

The sundry civil appropriation bill, as reported to the House, carries an item of $25,000 for the traveling expenses of the President of the United States, his attendants, and invited guests that may travel with him. Guardians of republican simplicity who think a President should be allowed no more than half a seat in a smoking car, with an occasional stand-up, such as his fellow countrymen endure, will, of course, throw the customary spasms over this appropriation; but those of more optimistic views are disposed to approve. The President in the discharge of his duties needs to come into contact with his fellow-countrymen. As to the disbursement of this large sum, it is to be presumed that no President will forget propriety—will allow the decoration of the right of way with champagne bottles, as too often has happened when a Senatorial funeral train has gone on its hilarious way.—*Exchange.*

New Interlockings on Union and Southern Pacific.

Following is a list of interlocking signal plants to be installed on the Harriman Lines this year. In some instances the number of levers is approximate, as the plans have not yet been completed.

Location.	Character.	No. of levers.
Union Pacific.		
Portal, Neb.	Railroad crossing	10
Lane, Neb.	Double track work	20
Valley, Neb.	Double track work	16
Ellsworth, Kan.	Railroad crossing	20
Topeka, Kan.	Double track work	60
Bonner Springs, Kan.	Railroad crossing	20
Armstrong, Kan.	Junction	18
Buford, Wyo.	Double track work	12
Hermosa, Wyo.	Double track work	12
Lookout, Wyo.	Double track work	12
Hanna, Wyo.	Double track work	12
Point of Rocks, Wyo.	Double track work	12
Rock Springs, Wyo.	Double track work	12
Canceled in 1905, but proposed for 1906, as follows:		
Central City, Neb.	Railroad crossing	16
Wymore, Neb.	Railroad crossing	8
Columbus, Neb.	Railroad crossing	20
Manhattan, Kan.	Railroad crossing	36
Abilene, Kan.	Railroad crossing	16
Omaha Union Depot		..
Southern Pacific Co.—Pacific System.		
East Oakland, Cal.	Junction	17
Fruitvale, Cal.	Junction	17
Webster St.	Junction	23
Southern Pacific.—Atlantic System.		
Englewood, near Houston, Tex.	Junction	25
Oregon Railroad & Navigation Co.		
Spokane, Wash.	Railroad crossing	47
Oregon Short Line.		
Ninth Street, Salt Lake	Railroad crossing	23

Canal Improvement Bonds.

The Controller of the state of New York will receive bids until June 14 for the purchase of $1,000,000 3 per cent. bonds of 1956. No bid will be accepted for less than the par value of the bonds. The proceeds of the sale will be used for canal improvement.

Manufacturing and Business.

The Quincy, Manchester, Sargent Company, Chicago, announces that James L. Pilling is no longer connected with that company.

W. A. Williams, who has been Acting District Manager at St. Louis of the American Car & Foundry Co., has been appointed District Manager. He will have charge of the new steel car plant in St. Louis, as well as the Madison steel car plant and the wood car shops and steel foundry at St. Louis.

The American Blower Co., Detroit, Mich., on May 25th invited the members of the Detroit Engineering Society to visit the plant in the afternoon, after which they were entertained by the company at a "beefsteak" supper at one of the city clubs. Immediately following the supper the regular meeting of the society was held, at which Mr. F. R. Still presented a paper on "Small Vertical High-Speed Self-Oiling Engines." The invitation met with a hearty response from the members of the society. The movement was initiated by the American Blower Co. with the idea that it would be followed by other manufacturers, giving the engineers of the city the benefit of visits to its various manufacturing plants.

Iron and Steel.

The Harriman lines are in the market for rails. These lines last year ordered over 200,000 tons for delivery this year.

The Wheeling & Lake Erie has ordered 10,000 tons of rails for 1907 delivery. Other contracts practically closed include the Baltimore & Ohio, 40,000 tons; Chicago, Burlington & Quincy, 25,000 tons, and the Seaboard Air Line, 25,000 tons. The sale of rails last week aggregated about 150,000 tons for 1906 delivery, and about the same quantity has been ordered for 1907 delivery.

The American Bridge Co. has received several additional orders for bridge material, including 3,000 tons for the Erie and 300 tons for the Baltimore & Ohio. The Florida East Coast, Southern Railway, and the Louisville & Nashville are reported to be negotiating for a heavy tonnage of bridge material to be used in 1907, and the New York Central and Erie to be inquiring for more tonnage to be used this year.

The Chicago, Rock Island & Pacific has ordered 36,000 tons of rails; the Atlantic & North Carolina 4,500 tons, and the Shreveport & Northwestern 2,500 tons, all for 1907 delivery. For delivery this year, the Chicago, Indianapolis & Louisville (Monon) has ordered 1,500 tons; the Shreveport & Northeastern 2,000 tons; the Atlantic & North Carolina 1,000 tons, and the Raleigh & Pamlico Sound 8,000. The United Gas Improvement Co., of Philadelphia, has also contracted for 2,500 tons, and the Union Pacific will, as reported, soon make contracts for 37,000 tons, and the Delaware, Lackawanna & Western for 15,000 tons for 1907 delivery.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad conventions and engineering societies, see advertising page 24.)

Transportation and Car Accounting Officers.

The spring meeting of this association was held at Denver, May 17, with about 100 members present from all over the country. An interesting address was given by Mr. A. D. Parker, Vice-President of the Colorado & Southern, who welcomed the members to Denver. The election for the ensuing year resulted in the choice of T. S. Bell (P. R. R.), Philadelphia, for President, and G. P. Conard, 24 Park Place, New York, Secretary. The fall meeting will be held at New Orleans in November. The report of the committee on office methods, embodying a proposed code of rules for tracing, was adopted. An abstract of this report was given in the *Railroad Gazette*, May 18, page 500. The report on handling railroad mail, also given in the *Railroad Gazette*, was accepted and the Secretary instructed to take a letter ballot as to the use of the letters R.R.B., R.R.S., or R.R.M. The matter of a uniform card waybill was not settled, as it is understood that the association of accounting officers will soon take up the subject. Diversion of cars was discussed at length, but the man with the magic wand to cure the troubles that afflict this department of the railroad service was not present.

Local Freight Agents.

The American Association of Local Freight Agents' Associations will hold its 19th annual convention at the Windsor Hotel, Montreal, June 19, 20, 21 and 22. The President of the association is A. D. Oyer (C. & N.-W.), Chicago, and the Secretary is G. W. Dennison (Pennsylvania and Hocking Valley), Toledo, Ohio. Following are the principal topics to be discussed:

Proper marking of freight; need of special marking for freight billed to shipper's order.

What charge, if any, should be made for car load freight received from industries, to be sorted at freight houses?

The yardmaster and the agent.

Best method of recording foreign cars with a view to the proper preparation of penalty notices.

Weighing carload freight under the rules of the Cincinnati Chamber of Commerce. These rules have stopped friction and complaints, and have given marked satisfaction.

Proposition to compile the results of the discussions in the association for the past 18 years.

Comparison of switching methods at different important cities.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Atlantic & Birmingham Air Line.—Alfred Walter, President of the Seaboard Air Line, has been also elected President of the A. & B. A. L., succeeding J. M. Barr.

Brockville, Westport & Northwestern.—E. R. Thomas has been elected President, succeeding John Gerken, who has been elected First Vice-President, succeeding Clarence P. King. Mr. King remains on the Board of Directors. E. R. Thomas, O. F. Thomas and W. I. Burgess have been elected Directors, succeeding H. W. Gennerich, Albert Berngaud and Carston Heilshorn.

Chicago, Rock Island & Pacific.—W. W. Stevenson, Controller, has resigned.

Grand Trunk.—A. A. Tisdale has been appointed Assistant to the Fourth Vice-President, with office at Montreal, Que.

Missouri, Kansas & Texas.—A. H. Joline, Counsel, has been elected Chairman of the Board, succeeding H. C. Rouse, deceased. R. W. McGuire, St. Louis, and Otto Miller, Cleveland, have been elected Directors.

The New York Central Lines.—Q. H. Smith, General Manager of the N. Y. C. & H. R., has been appointed Vice-President in charge of operation and maintenance on all lines east of Buffalo except the Rutland. C. E. Schaff, General Manager of the C., C., C. & St. L., has been appointed Vice-President in charge of operation and maintenance on the lines west.

Frederick Middlebrook, Assistant Treasurer of the Lake Shore & Michigan Southern and other New York Central Lines west, has resigned, on account of ill health. H. G. Snelling, Transfer Agent for Stocks and Bonds, succeeds Mr. Middlebrook.

Traffic Officers.

Great Northern.—F. I. Whitney, Passenger Traffic Manager, has resigned, effective July 1.

Lehigh Valley.—H. B. Crandall, Coal Traffic Manager and Fuel Agent, has resigned. W. T. Grier succeeds Mr. Crandall as Coal Freight Agent, with office at New York, the title of Coal Traffic Manager being abolished.

Southern.—F. H. Behring, Chief Clerk in the office of the Assistant Freight Traffic Manager at Louisville, Ky., has been appointed Assistant General Freight Agent, succeeding R. J. Curran, resigned to go to another company.

Engineering and Rolling Stock Officers.

Chicago, Burlington & Quincy.—F. Newton, road foreman at Sterling, Colo., has been appointed to the new office of Master Mechanic at that place.

Special Officers.

Chicago, Burlington & Quincy.—W. H. Hanss has been appointed Industrial Commissioner, with office at Chicago, Ill.

Operating Officers.

Boston & Albany.—Charles Firth, General Agent at Worcester, has been appointed Superintendent of the Western division (Springfield to Albany and branches), with headquarters at Springfield, Mass., succeeding N. Wales, resigned. Mr. Firth was born at Leicester, Mass., in 1860, and began his railroad service in 1880 on the Boston & Albany at Worcester as a clerk. From that position he was promoted to the position of agent at Rochdale, and from there, in 1887, to Westfield. After serving as agent at Westfield for 10 years he was for a short time city agent at Boston, and from that place was promoted to the agency at Worcester, which he now leaves. Mr. Firth is a nephew of the late Abraham Firth, who was Superintendent of the Boston & Worcester before its consolidation into the Boston and Albany.

Charles Firth.

Philip Morrison, Assistant Superintendent at Boston, has had his title changed to Superintendent, and J. B. Stewart, heretofore Superintendent, in charge of the whole road, is now General Superintendent.

Chicago, Milwaukee & St. Paul.—D. C. Cheney, Superintendent of the La Crosse division, has been appointed Assistant General Superintendent at Milwaukee, succeding H. B. Earling, promoted. P. C. Eldredge, Superintendent of the Prairie du Chien and the Mineral Point division, has been appointed Superintendent of the La Crosse and the Northern divisions, with office at Milwaukee. E. D. Wright, Superintendent of the Northern division, succeeds Mr. Eldredge.

Grand Trunk.—L. G. Coleman, Trainmaster at Montreal, Que., has been appointed to the new office of Assistant Superintendent at Ottawa, Ont.

Purchasing Agents.

Lehigh Valley.—F. L. Blendinger, Purchasing Agent, has taken over the duties of Fuel Agent, H. B. Crandall having resigned.

LOCOMOTIVE BUILDING.

The Kansas City Belt Railway has ordered two locomotives from the Baldwin Works for July delivery.

The Delray Connecting has ordered one 4-30 Baldwin type locomotive from the Baldwin Locomotive Works.

The Butte, Anaconda & Pacific, it is reported, has ordered six locomotives from the American Locomotive Co.

The J. A. Roebling's Sons Co. has ordered two 4-20 Baldwin type locomotives from the Baldwin Locomotive Works.

The Western Allegheny has ordered one consolidation locomotive from the American Locomotive Co. for August delivery.

The Seaboard Air Line has ordered 40 locomotives, 20 from the Baldwin Works and 20 from the American Locomotive Co.

The St. Louis & San Francisco, as reported in our issue of May 11, has ordered 20 locomotives from the Baldwin Works, and 20 locomotives from the American Locomotive Co.

CAR BUILDING.

The Texas & Pacific is considering the purchase of 500 box cars.

The Atlantic Coast Line is in the market for from 125 to 150 flat cars.

The Erie has ordered 100 Hart convertible cars from the Rodger Ballast Car Co.

The Standard Steel Co. has ordered four dump cars from the King-Lawson Car Co.

The Tonopah & Goldfield, it is reported, has ordered several cars from the Pullman Co.

The Capital Traction Co., Washington, D. C., has ordered 25 cars from the Cincinnati Car Co.

The Quebec Central is building 15 stock cars and two refrigerator cars at its Sherbrooke shops.

The Southern Pacific has ordered a number of additional baggage cars from Barney & Smith.

The Cincinnati Northern has ordered 20 closed cars for electric service from the Cincinnati Car Co.

The Macon, Dublin & Savannah, it is reported, is in the market for 100 box cars of 60,000 lbs. capacity.

The Washington Railway & Electric Co., Washington, D. C., has ordered from 40 to 50 cars from the St. Louis Car Co.

The Frisco System is reported to have ordered 2,000 box cars of 80,000 lbs. capacity from the American Car & Foundry Co.

The King-Lawson Car Co. is having 15 King-Lawson dump cars built at the Middleton Car Works. These cars will be used for general service.

The H. S. Kerbaugh Co., Philadelphia, Pa., has ordered 20 dump cars from the King-Lawson Car Co. They will be built at the Middleton Car Works.

The Temiskaming & Northern Ontario has purchased four second-hand passenger cars and will probably shortly place an order for four first-class passenger coaches.

The Canadian Pacific has completed a motor car at its Angus shops. The car is now being tested on its lines in the vicinity of Montreal. The company has also placed orders at its Angus shops for one sleeping car, one baggage car, 90 box cars, 85 flat cars and 15 stock cars.

The Solvay Process Co., Syracuse, N. Y., has ordered 15 tank cars of 8,000 gallons capacity and six tank cars of 6,000 gallons capacity from the American Car & Foundry Co., for June 30 and August 1 delivery. All cars will weigh 80,000 lbs., and measure 33 ft. long, over all. The special equipment for all includes: American Car & Foundry Co.'s standard bolsters, brake-beams and brake-shoes; Westinghouse brakes, Climax couplers, and Cardwell friction draft rigging.

The Lehigh Valley has ordered 10 express cars of 50,000 lbs. capacity, 10 express horse cars of 50,000 lbs. capacity, and one dining car from Harlan & Hollingsworth, for July and August delivery. The express cars will weigh about 108,000 lbs. and the express horse cars will weigh about 110,380 lbs. The express cars and express horse cars will measure 69 ft. 2½ in. long, over platforms; 10 ft. ¼ in. wide and 14 ft. 5¼ in. high, over all. The dining car will be 80 ft. 11½ in. long, over platform; 10 ft. ¼ in. wide and 14 ft. 5½ in. high, over all. The special equipment for all includes: Pullman cast-steel bolsters for dining car; Diamond Special brake-beams; American Brake-Shoe Co.'s brake-shoes; Westinghouse brakes; Mag-

nus Metal Co.'s brasses; Gould couplers, National curtain fixtures and Pantasote curtain material for dining car; Gould draft rigging; Soule dust guard for dining car; Gold heating system, Safety Car Heating & Lighting Co.'s light and Protectus paint for express and express horse cars; Gould platform for dining car; Lehigh Valley standard trucks and roofs; Railway Steel Spring Co.'s springs and Paige wheels for express and express horse cars.

BRIDGE BUILDING.

Battleford, Sask.—The Legislature has included $200,000 in its estimates for a new steel bridge.

Boone, Pa.—A contract is reported let by the Newton & Northwestern to the Marsh Bridge Co., of Chicago, for building a number of bridges along its proposed extension. The largest will be over the Des Moines river at Kato, south of Fort Dodge. It is to be a concrete structure, of three spans 175 ft. long.

Cornwall, Ont.—Bids are wanted June 18 by Adrian I. Macdonnell, County Clerk, for building two bridges, one over the south branch of river Aux Raisins and the other over Payne river.

Fredericksburg, Mo.—A bill has been introduced in the Lower House of Congress authorizing Gasconade County to build a bridge over the Gasconade river.

Fremont, Ohio.—The Lake Erie & Western has given a contract to the American Bridge Co. for building two steel bridges over both channels of the Sandusky river and the Wheeling & Lake Erie tracks. The proposed structures will be 443 ft. and 702 ft. long respectively, and will cost $100,000.

Helena, Mont.—Bids are wanted June 18 by Percy R. Witner, County Clerk, of Lewis and Clark County, for building a steel bridge 550 ft. long, 16 ft. wide and 12 ft. above the water, and approximately 61 ft. above the river-bed.

Kingwood, W. Va.—The County Court has accepted the offer of the Caddell Lumber Co. to build a bridge over Cheat river at Fairfax Ford, to cost $15,000, in Preston County.

Memphis, Tenn.—Engineers estimate the cost of a double deck viaduct for a proposed belt line and the Southern Railway at Pigeons Roost road at approximately $104,000. The question of abolishing the grade crossing at this point has long been under discussion. It is proposed to elevate the tracks of the Southern to allow the tracks of the belt line to pass under them, at the same time maintaining the proper height above the thoroughfare. The Southern had been making plans for a subway at this point, which, it is said, has been abandoned since the belt line has been projected.

Montana.—A bill has been introduced in both Houses of Congress authorizing the Chicago, Milwaukee & St. Paul to build a bridge over the Missouri river in Lewis and Clark County.

New York, N. Y.—Bids are wanted June 14 by the Department of Bridges for building the Manhattan subway station for the Williamsburg bridge.

Ohio.—The Upper House of Congress has passed a bill authorizing the Back River Bridge Co. to build a bridge over the west division of the Ohio river from Wheeling, W. Va., to the Ohio shore.

Pine Bluff, Ark.—Judge Kerwin has ordered that seven bridges ranging from 80 ft. each to 234 ft. be built in Jefferson County.

Prince Albert, Sask.—The Legislature has appropriated $50,000 towards the cost of enlarging the Canadian Northern bridge.

Regina, Sask.—The Saskatchewan government has decided to at once build the following bridges: Battleford, costing $200,000; Saskatoon, $100,000, and Prince Albert, $50,000. Hon. J. H. Lamont, Prince Albert, Saskatchewan, Minister of Public Works, can give particulars.

Saskatoon, Sask.—The Legislature has appropriated $100,000 for a new steel bridge here.

Toledo, Ohio.—The Osborne Engineering Co., of Cleveland, has been authorized to make plans for a new bridge to be 1,100 ft. long and 70 ft. or 80 ft. wide, to be built of reinforced concrete arches, with steel bascule spans over the Maumee river at Cherry street. The estimated cost of the bridge is $750,000.

Wilmington, N. C.—The Atlantic Coast Line has applied for authority to replace its bridge over Smiths creek by a new structure. The new bridge is to be of steel, double track.

Yreka, Cal.—Bids are wanted July 5 by Robert Rankin, County Clerk, for building four steel bridges over Shasta and Scott rivers in Siskiyou County.

Other Structures.

Atlanta, Ga.—The Louisville & Nashville has let the contract to the Ferro-Concrete Construction Co., of Cincinnati, for making its new freight terminals at Waverly Way, this city. The freight house will be five stories high, 835 ft. long by 50 ft. wide.

Chattanooga, Tenn.—Plans for the new union passenger station are said to have been accepted by the various railroads interested. It will be 316 ft. long and 80 ft. or 90 ft. wide.

Enola, Pa.—The new paint shop recently completed by the Pennsylvania at this place has been found too small and an addition will be built to it to cost $100,000.

Everett, Wash.—The petition of the Great Northern asking for the vacation of Bond street for a station site has been granted on condition that the company begin work on a new station to cost $50,000 during the next five months.

Hagerstown, Md.—The Western Maryland is to build three large shops here; a machine and erecting shop 240 ft. long and 100 ft. wide of brick and steel; boiler and engine house 50 ft. long and 30 ft. wide, and blacksmith shop 80 ft. by 50 ft.

Lorain, Ohio.—P. Farrell, of Cincinnati, who has the contract for the Baltimore & Ohio lake terminal improvements, expects to have them completed within a few weeks. The improvements include a 10-stall brick roundhouse, machine shop, blacksmith shop and boiler room, oil and storehouse, 30 ft. by 50 ft.; gravity coal tipple and sand house, a storage ash pit, 86 ft. long. There will also be a trainmen's building 35 ft. by 50 ft. to contain offices for the general foreman and clerks. Improvements are also being made to the B. & O. ore docks, consisting of the alteration of 10 ore-hoist machines to operate automatic buckets. The machines are also being equipped with a modern scraping device. The cost of this latter work will be about $100,000. The McMyler Manufacturing Co. has the contract for the ore machines, and has about completed the work. The scraping devices are being furnished by M. Andrews, of Cleveland. At Fairport, a new bridge is being built over the Black river, and additional tracks are also being laid at the coal docks at that place.

Pasco, Wash.—Plans have been completed by the Northern Pacific for putting up a machine shop and some other buildings.

Pensacola, Fla.—The Louisville & Nashville has rejected all the bids recently received for putting up its new station here, and, it is thought, the company will do the work with its own forces.

Perth Amboy, N. J.—The Pennsylvania has been buying land near Fayette and Division streets, and, it is said, has a site for a freight yard to include large freight houses. On the completion of this work, the present passenger station at this street is to be replaced by a new one on the ground opposite the Central station in Smith street.

Tulsa, Ind. T.—An agreement, it is said, has been reached by the residents and the St. Louis & San Francisco so that the work on a new station here to cost $25,000 can be started at once. Other improvements to be made will bring the total expenditures up to $100,000.

Waynesboro, Pa.—The Cumberland Valley is to put up a new freight house here. The plans call for a steel and brick structure 130 ft. 6 in. long and about 30 ft. wide.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

Atchison, Topeka & Santa Fe.—This company and the St. Louis & San Francisco are contesting for an outlet through Beaver County, Okla., into New Mexico and Colorado. The Santa Fe is planning to extend from Woodward, Okla., on the Panhandle branch northwest via Fort Supply and Beaver to a connection with the Englewood & Kansas branch, which is to be extended to Raton, N. Mex., and to build a cut-off east of Woodward, crossing the North Canadian river to Waynoka, Okla., which will eliminate the heavy grades and sharp curves near Quinlan. Permanent surveys are being made from Liberal, Kansas, south and west through Beaver County into New Mexico.

Canadian Northern.—Plans have been filed by this company for a line from Sudbury to Batchawaung Bay, Lake Superior, and from Sudbury round the north end of Lake Superior to connect with the Canadian Northern at Kashabowie, west of Port Arthur. See Mackenzie-Mann Roads.

Chicago Roads.—In an ordinance now before the city government provision will be made for the elevation in the city of Chicago of 57½ miles of road, at a cost of about $5,000,000. The roads and the estimated cost of elevation work and subways are as follows: Chicago & Western Indiana, $600,000; Pennsylvania Lines West, $1,600,000; Lake Shore & Michigan Southern, $1,500,000; Chicago, Rock Island & Pacific, $600,000; Baltimore & Ohio, $500,000; South Chicago, $150,000, and Chicago & Eastern Illinois, $20,000.

Cleveland, Cincinnati, Chicago & St. Louis.—A contract has been given by this company to Williams Brothers & Morse for double-track work and reducing the grades from Batesville, Ind.,

on the Chicago division, 49 miles west of Cincinnati, to McCoy, 11 miles.

COPPER RIVER.—Close Brothers & Co., of Chicago and London, in conjunction with American and European capitalists, are building this road to develop the Bering Lake coal fields, the Copper river copper fields and the rich gold districts on the upper Tanana Valley and other sections in the interior of Alaska. The proposed route is from Cordova, Alaska, near a bay of the same name, east to the Copper river, thence north along that stream to a point north of Taral, about 135 miles. An extension is projected north through Copper Center, Chisna and Mentasta Pass to Tanana Junction on the Tanana river. Branches are projected also from a point just north of Taral east along the Chitana river to Bonanza Mine, and from a point near the mouth of the Copper river south and east to a point east of Bering Lake. The work now under way is being done by M. J. Heney, contractor for the White Pass Railway. A considerable amount of grading has been finished, and it is expected to commence track-laying shortly. The work is not very difficult. The line and gradients are favorable, maximum grade being under one-half of 1 per cent. There will be two large steel bridges, both over the Copper river. The permanent organization of the company will not be completed until the contractors turn over the line for operation. The White Pass & Yukon is not interested in this project.

Copper River Railway.

CUBA RAILROADS.—According to Sir William Van Horne, President of this company, about 250 miles of new lines, to develop the resources of the island, and to provide an independent connection to Havana, will be built this summer. About 180 miles of this work will be needed for the Havana line.

The House of Representatives has voted a subsidy of $500,000, which is at the rate of $6,000 per kilometer, for building a number of short railroads. It has been left to the President to decide which lines shall receive the subsidy, but it is said that most of the money will probably go to the Van Horne system. Protests have been filed by other companies who claim they can build these lines without subsidies, and that the amount granted is excessive.

DANBURY & PORT CHESTER.—Incorporated in New York, with $100,000 capital, to build from Salem Center, Westchester County, New York, east to Ridgefield, Conn., about seven and one-half miles, thence south through Lewisboro and Poundridge, N. Y., to Highridge, Conn. J. G. Parker, E. G. Buckland, F. E. Hall, William Greenough and others, of New York, are incorporators.

EAST SIDE VIADUCT.—Incorporated in New York, with $50,000 capital, to build an elevated railroad from the terminus of the Harlem River branch of the New York, New Haven & Hartford at Willis avenue in the Borough of the Bronx, New York City, southward across the Harlem river and thence between First avenue and Avenue A to East 34th street in the Borough of Manhattan. It is proposed to build a six-track stone viaduct between Avenue A and First avenue and across Jefferson Park. The directors are: O. W. Barnes, of Fishkill, N. Y.; C. H. Cook, O. B. Nairs and L. C. Twombley, of New York, and F. H. Loomis, of Steubenville, Ohio. The southern terminus of this line is close to the Pennsylvania Railroad's underground line.

GRAND TRUNK PACIFIC.—Hogan & McDonald have sublet to M. P. Davis, of Ottawa, the building of 50 miles of line from the Cap Rouge bridge. Work is to be started at once.

A large contract for rock work on the section of this road east from Winnipeg has been let to Guy Campbell, of Ottawa.

J. D. McArthur, Winnipeg, has sublet work on the Winnipeg-Lake Superior section as follows: A. Herbert, 20 miles of prairie; W. Wardrop, 15 miles, and F. W. Smith, two miles of solid rock work.

During July the National Transcontinental will call for bids for the construction of the Quebec-Moncton section of this road. The commission has not yet decided which of the two routes will be used.

The McDonald-McMillan Co., Winnipeg, has started preliminary work on the Portage la Prairie-Winnipeg section. Construction work will be begun at once at a number of points on the section.

McIntosh Bros., of Petrel, Man., have secured a sub-contract on this road.

Location plans of new branches of the transcontinental system have been submitted to the Minister of Railways by the Grand Trunk Pacific. One of these is to run from Sudbury to Kashabowe, west of Port Arthur, 960 miles, where it will join the Canadian Northern. Another will run from Sudbury to Batchawaung Bay on Lake Superior, 170 miles. A third will run from Rumford on the Canadian Pacific west of Sudbury to the James Bay line. This branch is to take the ore deposits. The ore will be shipped either from Batchawaung Bay or Parry Sound.

GREAT BEND & GULF.—E. L. Peckham, of Denver, Colo., is the promoter of this company, which has applied to the Kansas Railroad Commission for authority to build from Hayes in Ellis County, Kansas, southeast to Arkansas City, 175 miles air line. It is intended to begin construction work next month.

GREAT NORTHERN.—A contract has been let to Campbell & Ferier, of Duluth, Minn., for building 80 miles of the Midland of Manitoba.

John Bradley, of Brandon, Man., has the contract for building the line from Brandon to the international boundary.

INDIANAPOLIS, COLUMBUS & SOUTHERN TRACTION.—W. G. Irwin, General Manager of this road, announces that a contract has been given to Howard Lee for grading work on 20 miles of the proposed extension south to Seymour. This extenson is to form one link in the proposed Indianapolis & Louisville Line. Work is to be started at once.

MACKENZIE-MANN ROADS.—In connection with the execution of their plans for the construction of a transcontinental system, Mackenzie & Mann presented to the Minister of Railways for approval a route map of a 560-mile stretch to the north of Lake Superior. The route they have chosen from Sudbury west is north of the Canadian Pacific main line, keeping at an average distance of about 20 miles all the way. It is to connect at a point called Kashaboine with the Canadian Northern's existing line just west of Port Arthur. The construction of this link around the north of Lake Superior would give Mackenzie & Mann a through line from Toronto to Edmonton. Plans are already before the government of the line that this company intends building through Ottawa to connect with Montreal and Quebec. The plan presented, on Monday, shows that they intend to build a branch line from Sudbury to Batchawaung Bay on Lake Superior. Their main line, north of Lake Superior, will keep to the north of the height of land which comes pretty close to the lake.

MINNEAPOLIS & ST. LOUIS.—An officer writes that the Minnesota, Dakota & Pacific, which is the western extension of this road in South Dakota, is to consist of two lines. The first is from Watertown, in Codington County, northwest via Bradley in Clark County, Conde in Spink County, and Aberdeen in Brown County, to Leola in McPherson County. The second is to be built from Conde in Spink County west via Mellette and Northville in the same county to Scranton in Potter County, thence to Lebeau. Grading is now in progress, but no track has yet been laid. The contractors are Winston Brothers Co., of Minneapolis. The ruling grades will be 0.5 per cent. and maximum curves 3 deg. There will not be any important bridges or trestles. L. F. Day is President, and G. H. Kelly, Chief Engineer, both of Minneapolis, Minn. (May 25, p. 155.)

MINNESOTA, DAKOTA & PACIFIC.—See Minneapolis & St. Louis.

MISSISSIPPI EASTERN.—This company, operating 12 miles of road in Mississippi, and now building an extension of five miles, intends to start work at once on an additional 10 miles.

NASHVILLE & HUNTSVILLE.—J. H. Connor, President of this road, denies that the road has been sold to the Atlanta, Birmingham & Atlantic. He says that the road will be built and operated as an independent railroad from Nashville, Tenn., via Birmingham and Montgomery to Pensacola, Fla. The company has been making surveys, and securing franchises, and ground for terminals during the past year, and is now about ready to let contracts for the

work. The new road will not have any connections with the A. B. & A., but will connect with other roads in Birmingham and Montgomery; and at Pine Hill, Ala., it will connect with the Mobile & Ohio, continuing south from Camden to Mobile through the Black Belt cotton section to Pensacola, where it has secured dock and terminal facilities. Entrance will be made into Nashville over the tracks of the Nashville Terminal Co., crossing the old Tennessee Central Belt line near Browns creek. It will use the same tracks and depot facilities as the Illinois Central and the Southern.

New York City Subways.—The Subway in Manhattan is now in operation to the northern terminus at 221st street, and the Broadway expresses run through from South Ferry to that terminus, about 14 miles. The station at 181st street has also been opened. This station is more than 100 ft. below the surface of the ground and has two large elevators. At 181st street connection is made with a new surface street car line running eastward from that station, crossing the Washington bridge and thence through 181st street to Fordham and beyond. This surface line is operated by the New York City Interborough Railway Company. This company is affiliated with the Interborough Rapid Transit Company, operating the Subway, and through tickets are sold over the two lines for eight cents.

The proposed west side subway, known as the Seventh and Eighth avenue route, has been approved by the Commission appointed last January by the appellate division of the Supreme Court, composed of Randolph Guggenheimer, Patrick A. Whitney and R. B. Moffat. The Commission reports that this subway should be built as soon as possible. The work would take about four years, and the cost would be about $41,000,000, and equipment would cost $15,000,000.

Northern Pacific.—A contract is said to have been let to A. Guthrie & Co., of St. Paul, to revise the line and grades, also to build a second track from Wadena Junction, Minn., where the double track at present ends, northwest for a distance of 87 miles to Moorehead, Minn.

Nova Scotia Eastern.—A new syndicate is petitioning the Legislature of Nova Scotia to extend the time for building this line from Halifax to Guysboro, with a branch line to or near New Glasgow to secure an outlet for the coal from the Pitcou collieries. An increase is also asked for raising the subsidy from $5,000 a mile to $12,000.

Oregon & Washington.—This company was recently incorporated in Oregon to build a railroad from Portland, Ore., north to Everett, Wash., 180 miles, air line. E. H. Harriman is President; J. D. Farrell, Vice-President; W. W. Cotton, General Counsel, and G. W. Boschke, Chief Engineer. Definite location surveys have not yet been made.

Organ Mountain.—This company has filed its charter in Texas. The capital is $100,000 and the office is at El Paso. The company is planning to build a railroad from El Paso to a mining district in the Organ Mountains of New Mexico, about 75 miles. The incorporators are: N. D. Streeter, of Philadelphia; Adriens A. Jones, of Las Vegas, N. Mex.; Harris Walthall, D. Y. Hadley, S. A. S. Cox, A. M. Walthall, H. W. Fall, W. S. Crombie, Dan M. Jackson, J. W. Eubank, all of El Paso.

Pan-American.—B. T. Davis, who has the contract for building the division of this road from Tonala, Mex., to the Guatamalan line, says that about 35 miles of the division have been graded and about 50 miles cleared.

Pennsylvania Lines West.—The Hickory branch of this road has been opened. It is from Burgettstown, Pa., on the Pittsburg division of the Pittsburg, Cincinnati, Chicago & St. Louis, to Cherry Valley, four miles. The Burgetts branch, from Burgettstown to Valcar, one mile, has also been opened.

St. Louis & San Francisco.—Surveys are being made by this company for extending the Arkansas Valley & Western from Avard, Okla., west through Beaver County to the New Mexico coal fields, touching Fort Supply and Beaver City. (See Atchison, Topeka & Santa Fe.)

St. Louis, Decatur & Champaign (Electric).—An officer writes that contracts have been let, but that no track has yet been laid on this proposed electric road from Champaign, Ill., southwest via Monticello and Decatur to Litchfield, about 125 miles. W. D. McKinley, of Champaign, is President, and W. H. Tarrant, of the same place, Chief Engineer.

San Francisco, Idaho & Montana.—This company, organized at Boise, Idaho, proposes to build a line from Butte, Mont., to Winnemucca, Nev. The directors, most of whom are eastern capitalists, it is said, have decided to at once begin the construction of the western section of the line. (See Construction Record.)

Schenectady & Southwestern.—Incorporated in New York, with $850,000 capital, to build from Margaretville in Delaware County, New York, on the Ulster & Delaware, northeast to Schenectady, about 60 miles, with a branch from Schenectady through Scotia to a connection with the Boston & Maine and the New York Central roads, and an additional branch from Schenectady to Rotterdam Junction. The directors are George P. Ford, George S. Fulton, Frederick J. Whan, of New York City; A. S. Brown, of Brooklyn, N. Y.; G. S. Hilton, of Paterson, N. J., and others.

Youngstown & Ohio River (Electric).—The proposed route of this road is from Salem, Ohio, east via Washingtonville, thence southeast via Leetonia, Lisbon and West Point to East Liverpool, Ohio, 34 miles. The company has already acquired six miles of track, from Salem to Washingtonville. The general contract for building the road has been given to the Cleveland Construction Co., Citizens' Building, Cleveland. The work will be rather difficult, the line being over a rough country. Maximum grades will be 2½ per cent. The plans for bridges have not yet been made. George A. Stanley, Electric Building, Cleveland, Ohio, is President, and W. E. Davis, Citizens' Building, Cleveland, Ohio, is Chief Engineer. (May 4, p. 138.)

RAILROAD CORPORATION NEWS.

Atlanta, Birmingham & Atlantic.—The Atlantic & Birmingham Construction Co., which is building the extension of the A. B. & A. to Birmingham, Ala., and Atlanta, Ga., has sold $8,000,000 5 per cent. 4 year collateral trust notes through a syndicate consisting of the Trust Company of America; Clark, Dodge & Co., New York, and the Old Colony Trust Co., Boston. The notes are secured by the deposit of $1,000,000 Brunswick Steamship Co. bonds; $1,000,000 Brunswick Steamship Co. capital stock; $1,206,000 A. B. & A. equipment notes; $3,000,000 capital stock of the Coal Company and the Iron Company; $6,000,000 A. B. & C. first mortgage bonds; $4,600,000 A. B. & A. preferred stock, and $10,000,000 A. B. & A. common stock. The sale of the notes will provide funds for the construction mentioned above and also for steamships, equipment, coal and iron purchases, shops and for tidewater terminals at Brunswick, Ga.

Brockville, Westport & Northwestern.—This company has passed into the control of E. R. Thomas and associates through the purchase by these interests of the United National Bank, which controlled the railroad company. The road runs from Brockville, Ont., to Westport, 45 miles, and has authorized $1,000,000 6 per cent. non-cumulative preferred stock and an equal amount of common. The bonded debt consists of 4 per cent. gold bonds of 1923 secured by a mortgage limited to $450,000.

Chesapeake & Ohio.—The Chesapeake & Ohio Railroad of Kentucky, the Kinniconick & Freestone, and the Big Sandy Railway Co., operating in all 349 miles, have been consolidated under the name Chesapeake & Ohio Railway Co. of Kentucky.

Erie.—This company, through its subsidiary, the Pennsylvania Coal Co., has bought the Clarabee Coal Co., whose annual output is about 100,000 tons and the Avoca Coal Co., whose output is 75,000 tons.

Pittsburg, Chartiers & Youghiogheny (P. C. C. & St. L. and P. & L. E.).—A meeting of the stockholders has been called for July 17 to approve an increase in the authorized capital stock from $1,000,000 to $1,500,000. This company owns 19 miles of road between Chartiers, Pa., and Beechmont. The $700,000 stock outstanding is owned jointly by the Pittsburg, Cincinnati, Chicago & St. Louis and the Pittsburg & Lake Erie, and these companies guarantee the $1,000,000 general mortgage 4 per cent bonds of 1932, of which $316,000 are outstanding.

St. Louis & North Arkansas.—This company, which owns 128 miles of road between Seligman, Mo., and Leslie, Ark., has been bought at foreclosure sale by D. R. Francis and associates. The St. L. & N. A. has $1,702,500 capital stock. Interest on the $3,065,500 outstanding 5 per cent. bonds of 1941 was recently defaulted.

Southern.—This company has sold $2,500,000 short term notes in London.

Twin City Rapid Transit.—This company, which operates all the street railways of Minneapolis, Minn., St. Paul and Stillwater, as well as interurban lines between the three cities, has authorized the issue of $2,100,000 additional common stock, making the total amount outstanding $20,100,000, there being $22,000,000 authorized. The holders of both preferred and common stock have the right to subscribe for this stock at par to the extent of 10 per cent. of their holdings.

Union Pacific.—This company has extended, until July 2, 1906, the right to exchange the first lien convertible 4 per cent. bonds into common stock. This right originally expired on May 1, 1906, and there are now $880,000 outstanding. Those that remain unconverted on July 2 will be called for redemption on Nov. 1, 1906, at 102½. (May 4, p. 138.)